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ABSTRACT

This resource guide was written to help teachers prepare students for a tour of the Lightship Chesapeake in Washington, D.C. However, much of the information would be useful in any unit on marine biology and water pollution. A glossary of nautical terms is included as well as possible laboratory assignments and related activities in such areas as social studies, language arts, and arts and crafts. (LS)

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ELEMENTARY TEACHER'S RESOURCE MANUAL

1973 - 1974

LIGHTSHIP CHESAPEAKE, NATIONAL CAPITAL PARKS

SE 016 952

Dear Teacher,

This resource manual is designed to help you help your students get the most from their visit to the Lightship Chesapeake. The manual is the result of a cooperative effort by D. C. classroom teachers and the education staff of National Capital Parks. It attempts to acquaint students, before their visit to the ship, with basic concepts and terminology of the marine environment.

In addition to a history of the Lightship Chesapeake, we have included a description of what your class can expect aboard ship, glossaries and word lists, and suggested unit outlines and classroom activities for preparation and follow-up of your visit. In the past, students who have been well prepared have been more receptive to their experiences on the ship and generally have learned more from their visit.

To give you the greatest possible selection, a wide range of material drawn from several disciplines has been included. We would be delighted if the manual also found its way to other classrooms via your colleagues.

For additional material, the ship's reference library is at your disposal and every staff member is available to assist you. We are looking forward to having you and your class aboard the Lightship and will do our very best to make it a memorable experience for all of you.

The Staff of the Lightship Chesapeake

TEACHERS MANUAL

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INTRODUCTION

We want to join with you to help your students have the best possible out-of-classroom experience when they visit the Lightship Chesapeake. We have put together this manual for you to use as you prepare the students, bring them to the ship, and--back in the classroom--help them integrate their experiences.

The most effective introduction to the knowledge and skills necessary to understand problems of the environment is firsthand observation and practice. Therefore the manual's orientation is toward activities the students can do themselves. They will then be able to draw on their own experiences to begin to formulate questions and opinions.

The manual is divided into three sections: (1) Sea and Anchor Detail, (2) Underway, and (3) Dry Dock.

The "Sea and Anchor Detail" is an introduction to the history of the development of lightships and the Chesapeake's own history. It includes a booklet for each student, a glossary of nautical terms, and some hints on activities you can do together in preparation for your visit. An additional preparatory aid is a slide show and accompanying script covering equipment and activities on board ship.

Section II, "Underway," describes the activities in which the students will participate during their day aboard ship. Included here is the purpose of each activity; what the students will actually do; and, most important, a list of suggested classroom mini-activities that will help them get the most from that portion of the shipboard experience. It is essential that these areas be covered by both student and teacher prior to visiting the ship.

The last section, "Dry Dock," contains resource material that will help to explain and reinforce concepts learned on board ship. Its wide range of material is by no means confined to the sciences. Its purpose is to expand the student's perspective and increase his understanding of environmental problems. Because of the multidisciplinary approach, you may want to call on teachers of art, language arts, or social studies to fully develop the instructional potential of this section.

The theme emphasized in this manual and aboard ship is the interaction and interdependence among men and all other living and nonliving things. Nothing exists in isolation. This theme will be explored in the crew members' efficient functioning, plant and fish life, and man's health, recreation, and industry. We will notice especially where and how ecosystems become overloaded or breakdown because one member is removed. These malfunctions have far reaching effects on all of nature, including man. Interdependence is illustrated didactically and by the content and format of the related activities and experiments.

I. SPECIAL SEA AND ANCHOR DETAIL

(Preparations for Getting Underway)

SAFETY RULES ABOARD SHIP

1. No running on deck.
2. No more than two children may have their feet on a ladder at one time.
3. Keep away from areas marked "Danger High Voltage."
4. Each child should have his nametag securely attached, and he should bring a pencil and paper with a cardboard for writing.
5. Both boys and girls should dress warmly with slacks and sneakers. Temperature on the water is nearly always lower than land temperature, and the wind can be surprisingly cold.
6. If rain is predicted, bring raingear.

INTRODUCTION TO LIGHTSHIP CHESAPEAKE

When the Lightship Chesapeake was decommissioned by the Coast Guard in January 1971, she was acquired by the National Park Service and converted to an interpretive environmental education facility. Fully refurbished and still completely operational, she is moored on the Washington Channel side of Hains Point where she serves the metropolitan area in the best tradition of the Park Service with a program of education, recreation, history and interpretation.

Education. In response to increasing national concern about environmental and ecological problems, the Lightship has become a platform for exchange of philosophical, cultural and scientific information about the redemption and protection of our natural resources. The District of Columbia schools, the Coast Guard, and the Park Service Education Division have cooperatively developed an environmental education program for fifth and sixth graders. The Lightship is a floating classroom where they participate in curriculum activities and projects as part of their school day.

The Lightship program also assists area high school students with environmental studies projects. Known as STEP (for Students Toward Environmental Participation), the program sponsors field studies and data evaluation in such areas as water quality analysis and marshland community relationships.

The Lightship makes available craft and equipment to college and graduate students for independent and supplemental studies in ecology and marine biology. Selected students have an opportunity to earn

academic credit for instructing high school study groups and elementary school classes. Students currently involved in advanced studies represent Georgetown, American and Maryland Universities, and Washington Technical Institute.

Citizens' groups concerned about pollution problems and environmental quality are invited to use the ship's labs and to go on educational field trips. The ship sponsors information meetings for community groups and stands ready with a variety of technical assistance.

Recreation. One way to get people interested in the state of the environment is to show them how much pleasure it can afford. During the summer months the Lightship sponsors small craft safety orientation and instruction in canoeing and sailing for area teenagers and adults. As part of the National Capital Parks' Summer in the Parks program, the Lightship daily hosts a "Wood-Duck Fun Trip" for children from neighborhood recreation centers. A less academic version of the school year program, the children spend the day learning about the ship, the river, and water pollution. They play games that teach about the ship's operation and safety, and then take a ride on the 42-foot carrier, the Wood-Duck.

History and Interpretation. Working closely with the District of Columbia schools and the Coast Guard, the Park Service has developed an interpretive program which highlights both the history of the Lightship as a valuable navigational aid and its current involvement in the life and problems of its new home in the Potomac Watershed area.

The Lightship Chesapeake is the main operations base for the Sea Explorer Program of the Boy Scouts of America. Sea Explorers, under Park Service guidance, spent months carefully restoring the ship and continue to have major responsibility for its operation and maintenance. Their efforts have made the Chesapeake a learning center where young people interested in environmental sciences can come together to explore problems and seek solutions firsthand. The ship offers the Sea Explorers many opportunities to master the nautical and technical skills needed on a seagoing vessel. Finally, for selected Explorers, there is the unique experience of living aboard an historical craft.

The Park Service believes that the effort and involvement of the Sea Explorers are its best interpretive tool. History and traditional mariners' skills are as demonstrably important to these young people as studying, understanding and protecting their environment.

THE CREW

In order for your class to be fully involved in the life of the ship, they should be familiar with the names and duties of the crew members. Do they know that high school young people, part of the Explorer unit, serve as crew and that crew billets are open to District area youth age 14 to 21? Here is a listing of some of the crew and their jobs aboard ship.

The Radarman is responsible for the operation of the ship's radar. He can identify dangerous situations and can locate land masses and aids to navigation by interpreting the signals on the scope.

The Signalman uses the semaphore, signal lanterns and signal flags to communicate with other ships, planes and shore stations. The International Morse Code is used by ships of all nations to talk to each other.

The Electronics Technician is responsible for the repair and efficient functioning of all electronics gear.

The Yeoman, as the ship's secretary, is responsible for all records and paperwork.

The Bos'n Mate's duties are to assist the officer of the deck. He is responsible for the organization and accomplishment of all work on the deck.

Seamen come aboard as apprentice workers in various departments on the ship and work their way through the three ranks of seamanship to become petty officers.

The Navigator plots the ship's position by using stars, observations and electronic means, giving particular attention to the course and the depth of the water when approaching land or shoals.

The Helmsman stands at the ship's wheel or helm and, using the ship's compass, steers a steady course.

The Master Chief Engineman is responsible for the operation of all machinery used to propell the ship and to support life on board.

Under the supervision of his chief, the Engineman maintains and operates engines.

The Machinist Mate repairs or rebuilds equipment.

The Boilerman is responsible for the safe operation of the heating system and the evaporaters which convert salt water to potable or drinkable water.

The Electrician's Mate is responsible for maintaining the supply of electric power and for keeping the electrical equipment in good repair.

Emergency situations such as collisions and fires at sea are handled by the specially trained Damage Control Man.

The Fireman stands "messenger," "cold iron" and "fire" watches; cleans and repairs emergency equipment; and records gauge readings.

The Commissaryman is cook, butcher and baker. He also prepares menus and orders, inspects and stows provisions. In all of these tasks, he is assisted by the Steward.

The Quartermaster performs ship control, navigation and bridgewatch duties. He corrects charts and also assists the officer of the deck.

The Radioman monitors incoming calls both voice and electronic signals.

Supplies are stowed, preserved, packaged and issued by the Storekeeper.

The specialized technician for medical duties on board is called the Corpsman.

Suggested Activities. Divide the class into several crew groupings. Let the children in each group each choose and represent a crew member. Two groups might set themselves up as shown in the examples below.

Sample Crew #1	Sample Crew #2
Cook	Electrician's Mate
Steward	Yeoman
Radioman	Seaman
Engineman	Seaman
Bos'n Mate	Signalman
Helmsman	Cook
Corpsman	Navigator

When the children return to the classroom after visiting the Chesapeake, they might want to revise their crew groupings. After being on the ship, they will have a clearer idea of what combinations of skills are essential to the ship's operation.

Each child might make a name tag similar to the sample below, drawing a picture which he thinks will represent one of the duties he might have if he were that crew member. It does not matter for now whether the student's choice of a symbol is correct or incorrect. He will have a chance to check out his thinking once on board ship.

WE'RE LOOKING FORWARD TO HAVING YOU ABOARD THE

LIGHTSHIP CHESAPEAKE

You are scheduled to visit the Lightship Chesapeake in the near future. So you can become familiar with the vessel before you arrive, let's talk a little about what kind of ship it is.

Take a minute and look in the dictionary to find a definition of the word SHIP. Are you surprised that there are so many different meanings of the word? You seee that any large seagoing vessel is a ship. How does that differ from the definition of a BOAT? Any sailing vessel with at least three masts, all rigged with square sails, is a ship. Any locomotive engine (which means one that supplies its own power) designed for navigation over the water is a ship. What do you call the craft that was designed for our astronauts to travel through space?

A ship is many things not mentioned in the dictionary. It is the road to far away places, a hotel, a war machine, a warehouse. It can act as a sea farmer, a factory, a policeman, or an explorer. The ship you will be visiting once belonged to the United States Coast Guard, the policemen and watchmen of our nation's waterways. The Coast Guard must maintain all lights, buoys and lighthouses, plus prevent smuggling and piracy.

A lightship (the Chesapeake's official designation) is actually a floating lighthouse that anchors on station for months at a time. With a beacon atop the main mast, the lightship's duty is to warn approaching ships of shoal waters or to mark the entrance to major shipping channels. The Chesapeake's beacon still works and is turned on each night.

There have been lightships since the tine of the Roman Empire. In those days, they were equipped with crude lights and manned by armed crews to discourage piracy. It was not until the 18th century that the English began to experiment with a fishing boat called a sloop equipped with two oil-wick lanterns suspended from a rod at the top of the mast. The sloop was stationed off the coast of England to warn sailors of shallow waters. However her crudely designed lights or lanterns were often extinguished by strong winds and sometimes completely carried away as the ship pitched and rolled in the violent seas. At other times the hemp anchor line would break and the ship drifted helplessly until the crew could sail her back on station.

In 1860, a Royal British Commission was appointed to recommend improvements in lighthouses and lightships; yet it was not until 1880 that experimental tests were finally made to improve the design of the ships. One lightship stationed off the French coast of Dunkirk was closely studied to determine the influence of such factors as hull

and keel design on the movement of the vessel. As a result of this study, hulls were redesigned, wood gradually gave way to iron and steel, and oil lanterns and reflectors were replaced by fixed electrical beacons with 250 to 1000-watt bulbs.

Thus, in 1930, when the Chesapeake (or WLV538 as she was known to the Coast Guard) was built in the Charleston, South Carolina ship yards, she represented the midpoint in lightship evolution from the 1880's to the present. As you approach her mooring, you will notice the resemblance she bears to the mythical "pirate ship" of the 1800's. Her red hull--all lightships are painted red with their station names printed on the side in large white letters--makes her look plump and squatty. The addition of two bilge or bottom keels decreased the amount of rolling while she was on station. Can you picture in your mind the difference in shape and overall appearance between a lightship, a sailboat, and a large streamlined passenger ship designed for speed rather than stability?

What about life aboard the Chesapeake while she was on station? The crew was responsible for a variety of duties 24 hours a day. Equipment had to be constantly monitored and repaired or replaced. The ship also served as a weather station and a radio station. Meteorological data was collected and observations reported every six hours. There was a fog signal to warn ships when the light was not visible and radio equipment for communications work. The Chesapeake also served as an oceanographic laboratory for recording water samples and temperature readings. Drift bottles were cast each day to record the flow speed and pattern. It was necessary for the crew to remain alert and conscientious in their duties and to be prepared for any emergency situation. The most notable near-disaster occurred on Ash Wednesday in 1962 when, in a severe storm, a wave ripped off the pilot house and almost rolled the ship completely over.

The Lightship spent most of her duty years at the mouth of Chesapeake Bay (hence, her name) although she did see service during World War II at the entrance to Cape Cod Canal near Sandwich, Massachusetts. Her station at the mouth of the Chesapeake Bay was closed to lightships in 1965 when the Coast Guard opened one of its new offshore "Texas Tower" stations. The ship then moved to the mouth of Delaware Bay where she remained until 1970 when this station too was closed.

After 40 years' service to her country and the shipping of the world, the Chesapeake was finally replaced by a "super buoy," 40 feet in diameter and weighing over 100 tons. These navigational buoys that have replaced lightships are equipped with powerful beacons plus fog signals, radio and radar beacons, and oceanographic equipment--all automated.

The Lightship Chesapeake's retirement, however, was brief and she now has a new mission in the service of her country. Recommissioned by the National Park Service of the Department of the Interior, she is a floating ecology classroom and historical museum and she warns us of the dangers in man's destruction of his environment.

We hope your visit to the Lightship Chesapeake will be an exciting and rewarding one. Upon your arrival you may be surprised at the amount and variety of equipment on board ship. To help you orient yourself to some of the the things you will see, we have included in the remainder of this booklet illustrations of some of the equipment plus a vocabulary for you to use to help you identify it and learn its uses.

Take a look at the cross section of the illustration of the Chesapeake. You see numbered compartments with corresponding explanations in the legend. Numbers 1 through 7 are illustrated. What color should they be? Where should they be placed on the ship? What determines their placement? Will you know their names when you see them? Can you name anything comparable in your home or school room? Color the illustrations, then take an imaginary tour through the various compartments so you will be familiar with them when you arrive at the ship.

Before your visit, you will also be seeing some slides of the ship and, on the day of your visit, a guide will give you a formal tour. See if the guide knows the equipment and parts of the ship as well as you do.

We are all looking forward to your visit to the Lightship Chesapeake.

Welcome aboard!

WHAT YOU CAN DO TO FIGHT WATER POLLUTION

WATER

1. Practice using less water.
2. Turn off the faucet while brushing your teeth.
3. Set a shower time limit, or take a shower with the plug in the drain to see if you can save water by taking a bath.
4. Try a quick wet down in the shower, no water while lathering, and a quick rinse off.
5. Place a brick in the toilet tank to raise the water level in the tank. Less water will be needed to control the flushing mechanism and less will be consumed with each flush.
6. Use clothes washers and dishwashers only when filled to maximum capacity.
7. A cold water jug in the refrigerator can provide a refreshing drink without having to run tap water until it gets cold.
8. Don't litter beaches, parks, waterways, streets, or roadsides. Sooner or later such litter is likely to end up in a lake, stream, or river as a form of pollution. Pick up after a picnic.

ELECTRICITY

1. Conserve electricity during the peak hours of 5 to 7 p.m. Avoid unnecessary electric gadgets: toothbrushes, shavers, can openers, scissors, knives, frying pans, and hair curlers.
2. Use low-watt bulbs if high intensity lighting is not really needed.
3. Turn off lights and lower heat during daylight hours.
4. Proper insulation can greatly reduce the amount of heat you need: Weatherstrip joints, insulate the ceiling and walls, use storm windows, plant tree protection to shield against winter winds, and use blankets rather than your thermostat to keep warm; clean radiators.
5. Awnings, trees and a clean air filter will reduce summer heat. If you have an air conditioner, use it only when people are at home.

AUTOMOBILES

Automobiles are the number one cause of air pollution. Air pollution eventually ends up in the water when air currents bring the air in contact with bodies of water where the air releases some of its pollutants.

1. Keep your car in good running shape. You will use less gas, get more miles to each gallon, and produce less pollution.
2. Drive in carpools; better yet, walk or ride a bike when possible.
3. Consider buying a smaller car with a four or six cyninder engine.
4. Use sand instead of salt on icy sidewalks and streets. Salt will damage nearby plants.

CONSUMABLE GOODS

1. Recycle and fix up your toys; trade with a friend; start a toy swap.
2. Try to find and use a recycling center for newspapers, aluminum, tin cans, steel and glass.

3. Buy returnable bottles and return them.
4. Avoid using paper products when reusable products are available. Use cloth napkins, towels, tablecloths, placemats, handkerchiefs, and diapers.
5. If you do use throwaway items, use paper rather than plastic which is slower to decompose.
6. Use a cloth or basket container to shop when feasible.
7. Use a lunchbox rather than paper bags.
8. Store food in reusable containers.
9. Reuse gift wrapping, Christmas wrapping and advertising mail.
10. Don't throw away hangers; if you can't use them, give them to someone who can.
11. Avoid individually wrapped cellophane packages of items like cheese and lunchmeat.
12. Separate trash. Be careful of what you throw away; film scraps can kill fish and wildlife.
13. Use only the amount of detergents and soaps required. This may be less than the recommended amount.
14. Use baking soda and washing soda as alternatives to all-purpose cleaners.
15. Try to use non-phosphate detergents or soap.

GLOSSARY OF NAUTICAL TERMS

ABAFT. A relative term to describe that one object is further aft than another. Thus: the mainmast is abaft the foremast. Pronounced: a-baft.

ABEAM. The direction at right angles to the keel of the boat.

ABOARD. On or in the boat.

ABREAST. Side by side.

ADRIFT. Not made fast; lying around loose; at the mercy of wind and wave.

AFT. In, near, or toward the stern of a boat; opposite of forward. For example: Go aft. The capstan is aft.

AFTER. Toward the stern. Same as aft except in the adjective form as, The capstan is in the after part of the ship.

AGROUND. On the bottom; stranded (usually a miserable situation).

AHEAD. In a forward direction.

AMIDSHIPS. Midway between the bow and the stern.

ANCHORAGE. A sheltered area where boats can anchor in reasonable safety and not interfere with marine traffic.

ASTERN. Behind a boat; in a backward direction.

AUXILIARY. A boat equipped to be propelled by sail, by power, or by both used together.

AWEIGH. Said of an anchor when it is clear of the bottom.

BACKSTAY. A wire brace led aft from the mast to support it against the pressure of the wind.

BAROMETER. An instrument for measuring atmospheric pressure.

BEAM. The greatest width of a vessel.

BEAM SEA. A sea running at right angles to the boat's course.

BEARING. The direction of an object from a boat. It may be a relative bearing (measure from the bow 180^{o} on each side) or a compass bearing (how the object lines up with a magnetic compass). It may also be related to the true direction on the earth.

BEAT. A zigzag course against the wind. To sail to windward by zigzag tacks.

BEAUFORT SCALE. A table describing 12 stages of the velocity of winds from calm to hurricane.

BELAY. A command to stop. A line is belayed when it is made fast.

BELAYING PIN. A wooden or metal pin fitted into a rail and used for securing sheets and halyards.

BELL. A warning signal or a means of announcing time aboard a boat.

BELOW. Beneath the deck.

BEND. To make fast; also, a knot by which a rope is made fast to another.

BIGHT. Any part of a rope except the ends; usually refers to a curl or loop in a rope.

BILGE. The curved or angular part of the hull where the bottom and sides meet; also, the internal part of the boat below the waterline.

BINNACLE. Protective casing to house the compass and its compensating magnet.

BITT. A post or fitting to which mooring lines are secured.

BITTER END. The last part of a rope or the last link in an anchor chain.

BLOCK. A pulley or system of pulleys in a frame used for transmitting power or changing the direction of motion.

BOAT. A small open vessel propelled by oars, sails, or engine.

BOOM. A spar at the foot of a fore-and-aft sail to which the sail is secured.

BOOM CRUTCH. A notched upright board or metal structure into which the boom fits when the sails are furled or off the spars.

BOW. The forward or front end of a vessel. Pronounced: bou.

BOW CHOCKS. Metal deck fittings at the bow through which anchor and mooring lines are led.

BOWSPRIT. A spar extending forward beyond the bow to which the headsails are attached.

BREAK OUT. To remove from a storage space.

BRIGHTWORK. Woodwork on a vessel which is varnished or finished to show its grain; also refers to polished brass or chrome.

BROACH TO. To fly into the wind unintentionally. A vessel under sail, running with the wind on the quarter, may be struck astern by a sea or be badly steered, causing the ship's head to come up suddenly toward the wind.

BULKHEAD. A wall or partition between compartments, often watertight for safety.

BUNK. A seaman's bed. Also, something reported that is not true.

BUOY. A floating marker anchored to the bottom.

BURDENED VESSEL. The vessel which, according to the rules of the road for two approaching vessels, must keep out of the way of the other; opposite of privileged vessel.

CABLE. A wire rope or chain secured to the anchor.

CAPSTAN. An apparatus for hauling in cables and hawsers.

CARRY. The forward momentum of a boat after it has come head into the wind.

CAST OFF. To let go of a line. To free a ship from a dock, quay, etc.

CAULK. To make seams watertight by filling them with cotton, oakum, or caulking compound.

CENTERBOARD. A movable plate of wood or metal that can be raised or lowered through the keep of a sailboat to prevent the boat's sliding to leeward.

CHAFING GEAR. A wrapping of canvas or rope around spars, rigging, or lines to prevent chafing or wearing.

CHART. Mariners' version of a road map used for navigation. Distance on a chart is measured in nautical miles.

CLEAR. Free, not entangled.

CLEAT. A horned fitting of wood or metal to which lines are made fast.

CLEW. The after lower corner of a fore-and-aft sail.

CLOSE-HAULED. Sailing as close as possible to the wind.

COAMING. A rail or raised frame around deck openings and cockpits to prevent water from entering.

COCKPIT. Open part or well of the boat where passengers sit and the helmsman steers.

COIL. To lay a rope down in circular turns. A coil of rope is 200 fathoms.

COLORS. (1) The ceremony of raising or lowering the national ensign and other recognized flags. (2) The national ensign or flag flown by a ship. "Dipping the colors" - ships salute each other by lowering and quickly raising again their colors. "Strike the colors" - lowering the flag when defeated in battle.

COME ABOUT. Bringing a sailboat from one tack to the other by swinging her bow across the wind. This brings the sails to the other side and permits it to sail at the same angle but with the wind on the other side.

COURSE. The intended direction of a ship's path across the water; also the point of the compass toward which the boat is steering.

CRINGLE. A ring sewn into the sail so that a line can be passed through it; similar to a grommet in the edge of a tent or on a sneaker.

CROSS BEARING. Two or more bearings of known objectives noted and plotted on a chart in order to determine the ship's position.

CURRENT. The movement of water in a horizontal direction.

DEAD RECKONING. The process used to determine the position of a vessel at any moment during periods when no celestial or terrestrial observations can be made.

DECKHOUSE. An upperdeck cabin which does not extend over the full breadth of the vessel.

DEVIATION. The change in the compass reading caused by the magnetic influence of the iron and steel in a boat and its equipment.

DISPLACEMENT. The weight of the water displaced by a vessel afloat.

DITTY BAG. A small bag for carrying or stowing small articles of gear such as thread, needles, tape, etc.

DOWNWIND. To leeward.

DRAFT. Distance from the water surface to the lowest part of the keel.

EASE. To slacken or loosen.

EMBARK. To go on board.

ENSIGN. The flag of the United States of America.

FAKE DOWN. To coil down a rope so that each fake (flat coil) overlaps the one underneath and is free for running out rapidly.

FAST. A rope of chain by which a vessel is secured to a wharf, pier etc.

FATHOM. A seagoing measure of six feet.

FENDERS. Portable bumpers made of canvas, wood or rope and hung over the sides to protect the hull from contact with dock or other boat. You may also see automobile tires used for this purpose.

FID. A tapered wooden tool used to separate the strands of a rope before splicing.

FITTINGS. General name for ship's hardware.

FIX. The determination of a ship's position be observation of celestial or terrestrial objects, or by a combination of both.

FLEMISH. To coil a line in a flat mat-like fashion.

FLOTSAM. Goods lost in a shipwreck and found floating.

GAFF. The spar to which the head of a fore-and-aft sail is secured.

FLUKE. The flattened end of an anchor arm.

FORE AND AFT. In line with the keel; lengthwise from stem to stern.

FORESTAY. A stay leading from a mast forward.

FORWARD. Toward the bow.

FOUL. Not clear; jammed; tangled.

FRAME. A boat's rib.

FREEBOARD. The distance between the waterline and the main deck or rail.

GALLEY. A boat's kitchen.

GEAR. General name for blocks, tackle, ropes, and other equipment used in operating a boat.

GROUND TACKLE. The anchor and anchoring gear.

GUNWALE. Upper edge or rail of a boat's side. Pronounced: gun-l.

HALYARD. A line used for hoisting sails or flags.

HANDSOMELY. Gradually or carefully, as when slacking or easing a rope on which there is a strain.

HATCH. An opening through the deck to a cabin or area below.

HAWSER. Fiber rope 5 to 24 inches in circumference, used for towing or working the ship.

HEAD. The toilet aboard a boat.

HEADING. The direction in which a ship actually points or heads at any particular moment.

HEAVE. To throw or pull a line. The erratic and sudden movement of a ship's bow in a seaway as differentiated from rolling and pitching.

HEAVE IN. To pull, as on an anchor line.

HEAVE TO. To bring a vessel's head to the wind or sea and hold her there by using sails or engines. This position is known as "lying to." A sea anchor or the slow motion of the propeller may be used to avoid broaching to. Heave to is also used to mean "get to work."

HEAVE OUT. An order to get out of one's bunk.

HEAVING LINE. A light line or "messenger" attached to a heavier line and thrown to a pier or other vessel.

HEEL. (1) To list over or incline to one side or the other. (2) The lower end of a mast, boom, etc.

HELM. The steering device; tiller, wheel.

HELMSMAN. The person who steers.

HITCH. A knot, usually temporary, which is designed to be untied quickly.

HOLD. To put on additional turns of line to prevent slippage.

HOOK. Sailor's name for an anchor or boat hook.

HULL. The main body or shell of a boat, exclusive of superstructure.

JACK. A small flag or pennant flown on the bow to show a ship's nationality; a single flag flown on the foremast as signal for a pilot.

JETSAM. Goods thrown overboard to ease a ship in peril. Jettison: the act of throwing goods overboard.

JIB. A triangular sail set ahead of the foremast on a sailboat.

JIBE. Bringing a sailboat from one tack to the other by swinging her stern across the wind in order to bring the sails to the other side. To shift suddenly and forcefully from one side to another when running before the wind.

JIB SHEET. The line by which the angle of the jib is controlled.

JURY RIG. A makeshift rig.

KEEL. The backbone of the boat; the basic support extending from stem to stern post at the bottom of the boat.

KINGSPOKE. The upper spoke of the steering wheel when the rudder is fore and aft.

KNOT. One nautical mile per hour. The international nautical mile equal to 6,076 feet was accepted by the United States in 1959. The British nautical mile is 6,080 feet. Because knots means "nautical miles per hour," you can describe the speed by saying the ship is making so many knots.

LANDLUBBER. What you are not when you become a seaman.

LANYARD. A short line used for making anything fast.

LAY. The twist of a rope's strands.

LEAD. In sailing craft, this is the distance between the center of effort and the center of lateral resistance.

LEE. Pertaining to the part or side toward which the wind blows, or which is sheltered from the wind.

LEEWARD. Toward the lee side or away from the wind. Pronounced: loo-ard

LEEWAY. A drift to leeward, or in the direction toward which the wind is blowing.

LIMBERHOLES. Holes in the floor timbers or frames to allow bilge water to drain into the lowest part of the hull.

LINES. Ropes used for various purposes aboard a boat.

LOCKER. A chest, box, cabinet, or closet used as a storage compartment.

LOG. A record of a vessel's activities. Also, an instrument for measuring distance traveled.

LOGBOOK. A record of all the activities of a ship. This is a compulsory record in the Navy and on Sea Explorer ships.

LUFF. The forward or entering edge of a sail.

LUFFING. The quivering of the luff when sailing almost directly into the wind.

MAINSAIL. The boat's main or principal sail. It is set on and abaft of the mainmast and extended by the main boom.

MAINSHEET. The line by which the trim or angle of the mainsail is controlled.

MAKE FAST. To secure the belaying turns of a rope around a cleat belaying pin by adding a single hitch.

MARLINSPIKE. A pointed steel tool used by seamen to separate the strands of rope when splicing; it can also be used as a lever when putting on seizings, marling, etc.

MIDSHIPS. A position which is midway between the sides of the hull.

MIZZENMAST. The after and shorter of two masts on yawls and ketches; the aftermost of three masts on a three-masted schooner or bark.

NAUTICAL MILE. Known as a sea mile, it is 6,076 feet long.

OUTBOARD. Toward the sides of a vessel or outside of it.

OUTHAUL. A device and/or line used to haul out the clew (after corner) of a sail along a boom.

OVERHANG. The projection of the bow and stern beyond the waterline. The overhang of the bow is generally called rake (the forward projection) and flare (the side projection).

PAINTER. A line at the bow of a dinghy for securing it. A bow line of a lifeboat equipped with a toggle pin for quick release in a seaway is called a sea painter.

PAY OUT. To pass or let out a line.

PEAK. The angle formed by the head and leech of a gaff sail. The greater the angle, the less peak the sail is said to have.

PILOTING. The method of directing a vessel from place to place by soundings or by reference to visible landmarks.

PIPE DOWN. An order directing everyone to be quiet.

POINT. To head close to the wind.

PORT. The left side of a vessel looking toward the bow.

PRIVILEGED VESSEL. One which has the right of way and should under normal conditions keep her course and speed.

QUARTER. That part of a craft lying approximately 45 degrees from the stern; starboard or port quarters refer to right and left corners respectively. "broad on the quarter" is 45 degrees.

QUARTERDECK. The stern deck area of a vessel. Also the ceremonial area near the gangway on larger military ships.

RAIL. The boat's side above the deck line.

REEF. To reduce sail area.

REEVE. To thread a rope through a block.

RIGGING. A general term for all ropes, chains, and gear used for supporting and operating masts, yards, booms, gaffs, and sails.

RIGHT-OF-WAY. The legal right to hold one's course.

ROPE. A general term for cordage over 1 inch in circumference. Less than 1" is called "small stuff." Rope may be wire, natural fiber or synthetic. Manufacturers use the term rope while sailors prefer to say line or, if metallic, wire.

RUDDER. A device used for steering and maneuvering a vessel.

RULES OF THE ROAD. The rules and regulations, accepted by international agreement and enforced by law in maritime countries, which govern the movements of ships when approaching each other.

RUNNING. Sailing with the wind astern.

RUNNING RIGGING. All moving lines used to control sails or other moving parts on the ship and rigged through blocks and fair leads. It does not include shrouds or stays which are parts of the standing rigging.

SAIL. A piece of fabric of some kind spread to the wind to cause or assist a vessel to move through the water.

SCOPE. The length of cable measured from hawsepipe to the anchor.

SCUTTLEBUTT. A drinking fountain on a ship or naval installation; also rumor or gossip.

SEA AND ANCHOR DETAIL. All the preparations necessary to get a ship underway.

SEAM. The joint between adjacent planks.

SECURE. To make fast a line; to leave a boat safely moored or tied up with everything aboard shipshape; also, to tie down a movable part.

SEIZE. To bind, lash, or make fast one rope to another or a rope to a spar, etc.

SERVE. To bind or wind a rope tightly with small cord, spun yarn, or marline, keeping the turns very close together.

SHACKLE. A U-shaped piece of iron or steel with eyes in the ends, closed by a shackle pin. In conjunction with a thimble, it is used to connect lengths of chain, wire, or fiber line.

SHEAVE. A grooved wheel in a block, mast, or yard over which a rope passes.

SHEET. A rope or chain fastened to one or both of the lower corners of a sail and used to extend it or change its direction.

SHIP. A vessel of considerable size navigating deep water and not propelled by oars, paddles or the like. Boats may be carried on board ships; never the other way around.

SHIPSHAPE. In correct fashion aboard a ship; everything orderly, secure and in its place.

SHOAL. A place where the water is shallow. A sand bank or sand bar in the bed of a body of water, especially one which shows at low tide.

SHROUDS. Wire stays leading from the upper part of the mast to either side of the deck to provide lateral support for the mast.

SLACK. To ease off; to pay out enough line to maintain a catenary.

SLACK AWAY. Pay out a line until told to stop slacking.

SNUB. To check a rope or line from running out by making a turn about a cleat, piling or post.

SPAR. Any boom, mast, gaff, etc. used to support or extend a sail.

STARBOARD. The right side of a vessel, looking forward.

STAY. Part of the standing rigging. A wire or line which supports a mast in a fore and aft direction.

STEM. The vertical timber of the leading edge of a boat.

STERN. The after part or back end of a vessel.

SURGE. A ship's back and forth movement in her mooring lines due to swell. Also, to slip a line around a capstan, bitt or cleat while maintaining a frictional resistance.

SWAB. A seagoing name for a mop with which one "swabs down."

TACK. To change the course of a ship when sailing by the wind by turning her head toward the wind, so that she will sail at the same angle but with the wind on the other side.

THWART. A transverse brace in a boat.

THWARTSHIPS. Crosswise of the deck; at right angles to the fore and aft line.

TILLER. The handle attached to the rudder by which the boat is steered if it is not equipped with a wheel.

TOPSIDES. The sides of hull above the waterline; on deck.

TRANSOM. The framework of the stern; the boards forming the flat stern area of any boat not having a pointed stern.

TRIM. The position of a boat or ship in the water usually with respect to the horizontal plane. A ship is said to list when she leans to one side or is not on an even keel. Trim also refers to the set of a boat's sails.

TRUE WIND. The direction of the wind as observed from a stationary object so as to rule out the factor of the observer's own motion.

UNDERWAY. Describes a vessel neither at anchor nor made fast to the shore.

VARIATION. Difference in direction between true north as determined by the earth's axis of rotation and magnetic north as determined by the earth's magnetism.

VEER. To slack off and allow to run out, e.g. to veer more anchor line.

WAKE. The track a vessel leaves astern.

WATCH. The part of a ship's company on duty or working at one time.

WAY. A vessel's progress or motion through water. A vessel gathers way when its speed increases. It is proper to use the term "underway with way," but usually saying "underway" will suffice.

WEATHER SIDE. The windward side; the side toward the wind.

WINDWARD. The direction from which the wind is blowing. Pronounced: win-ard.

YARD. A slender rod or spar fastened across a mast to support a sail.

YAW. To swing or steer widely out of the line of course, usually when running before heavy, quartering seas.

SAFETY RULES ABOARD SHIP

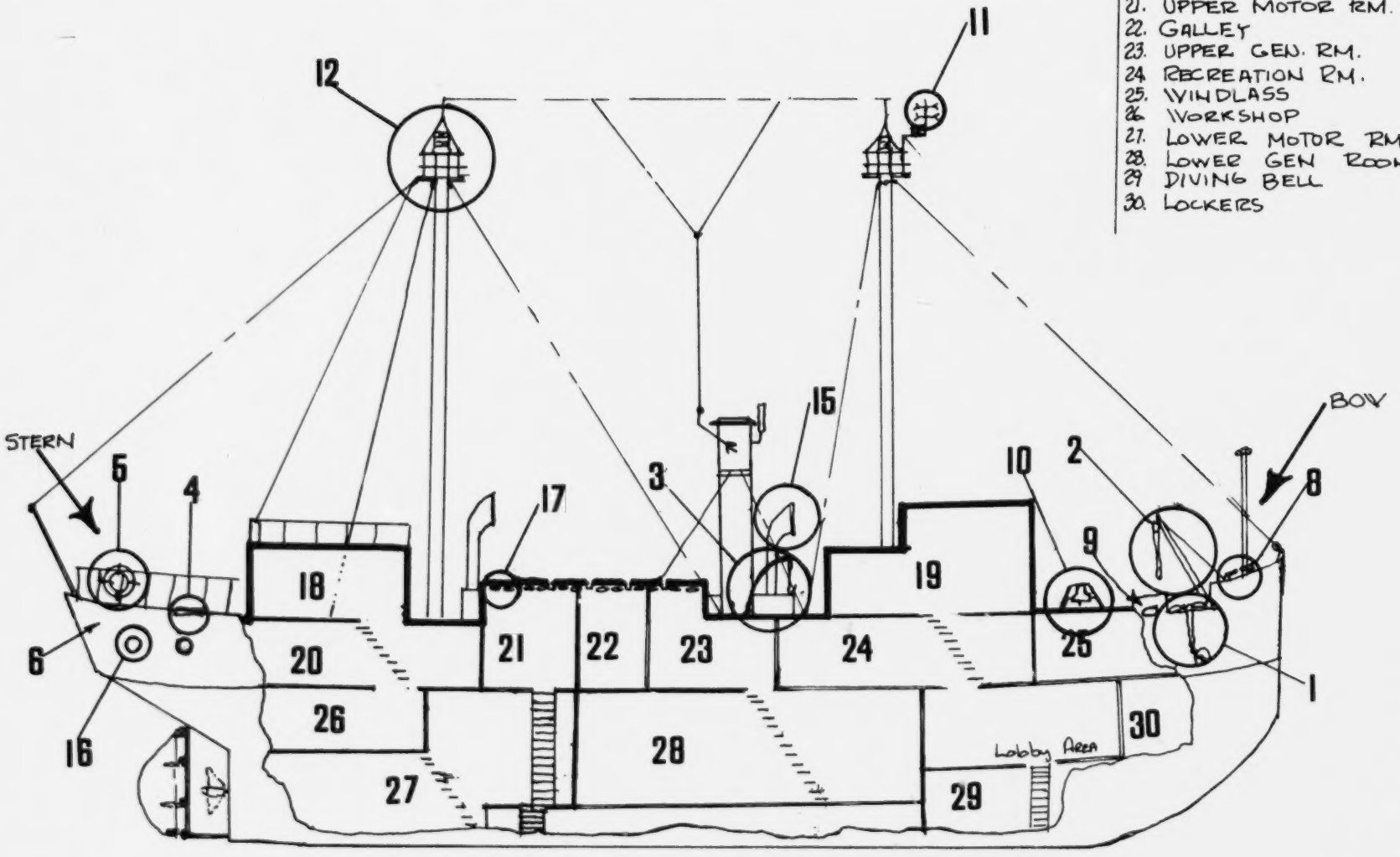
1. No running on deck.
2. No more than two children may have their feet on a ladder at one time.
3. Keep away from areas marked "Danger High Voltage."
4. Each child should have his or her nametag securely attached.
5. Bring a pencil and paper with a cardboard backing for writing.
6. Boys and girls should dress warmly with slacks and sneakers. Temperature on the water is nearly always lower than land temperature, and the wind can be surprisingly cold.
7. If rain is predicted, bring raingear.

~LEGEND~

FOR NUMBERS 1-17
SEE DWG'S IN THE GLOSSARY.

~LEGEND~

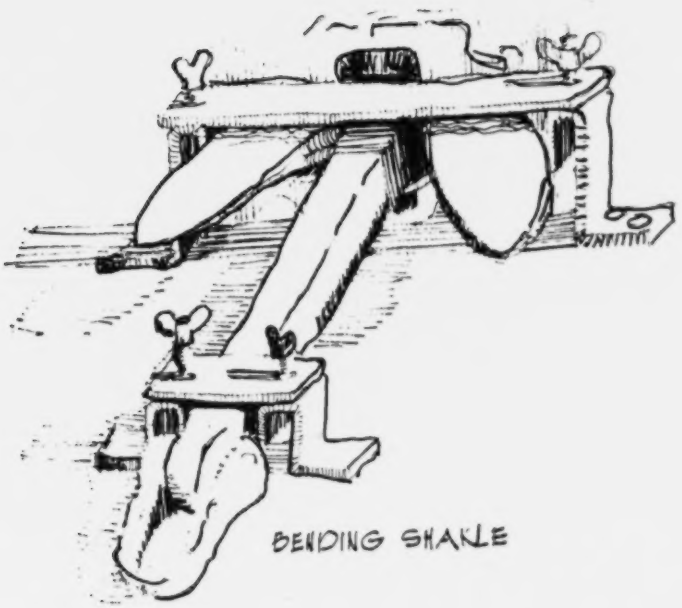
18. RADIO ROOM
19. MASTERS QUARTER & PILOT HOUSE
20. WARD ROOM
21. UPPER MOTOR RM.
22. GALLEY
23. UPPER GEN. RM.
24. RECREATION RM.
25. WINDLASS
26. WORKSHOP
27. LOWER MOTOR RM.
28. LOWER GEN ROOM
29. DIVING BELL
30. LOCKERS



SCHEMATIC DWG OF THE LIGHT SHIP
NO SCALE.

(1) PATENT ANCHOR

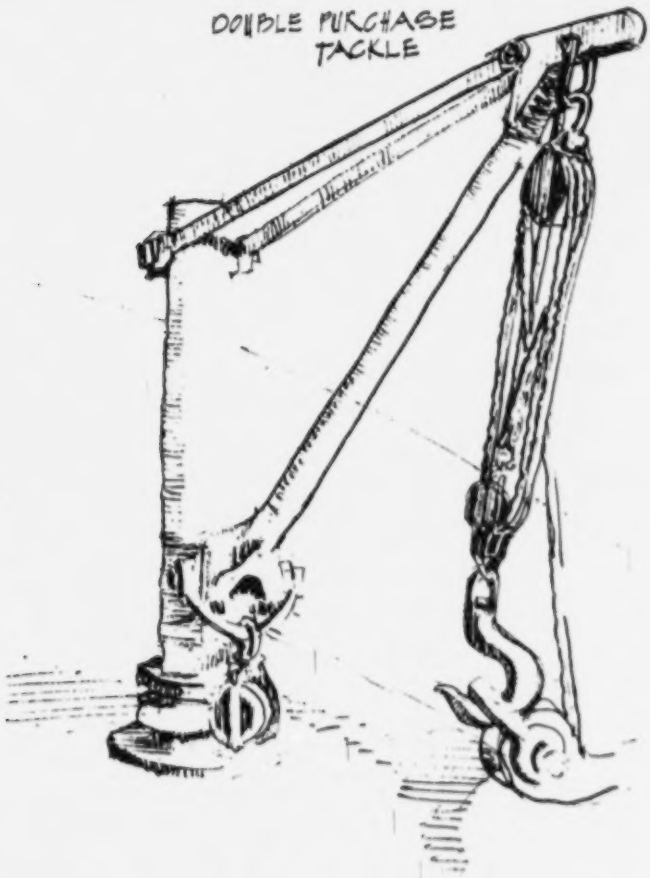
USED FOR DOCKING & AS STERN ANCHOR.
ALSO CALLED STOCKLESS OR NAVY ANCHOR



BENDING SHACKLE

(2) DECK HOIST

FOR LOWERING RESERVE ANCHOR

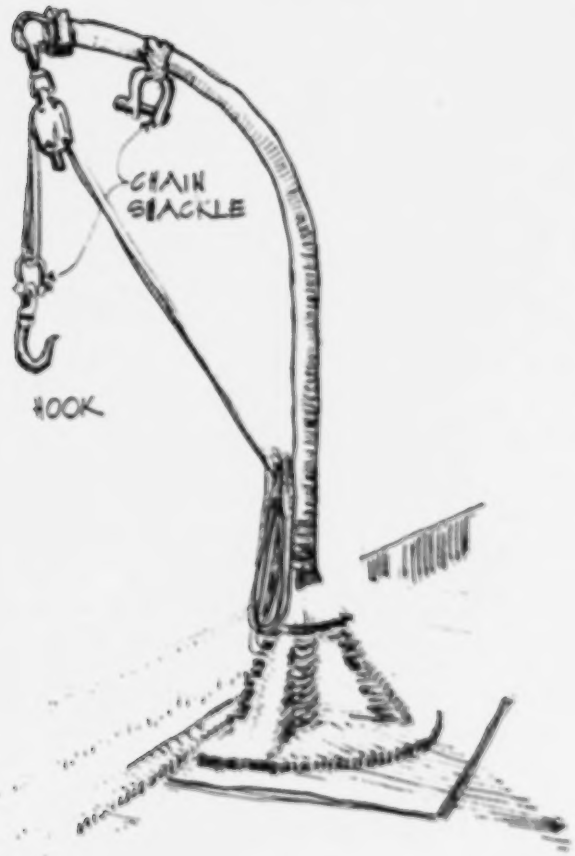


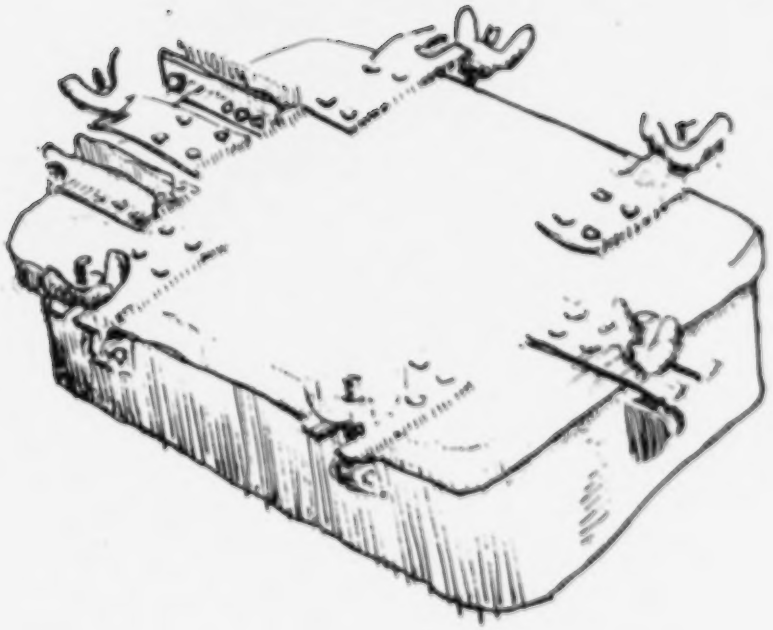
DOUBLE PURCHASE TACKLE

③

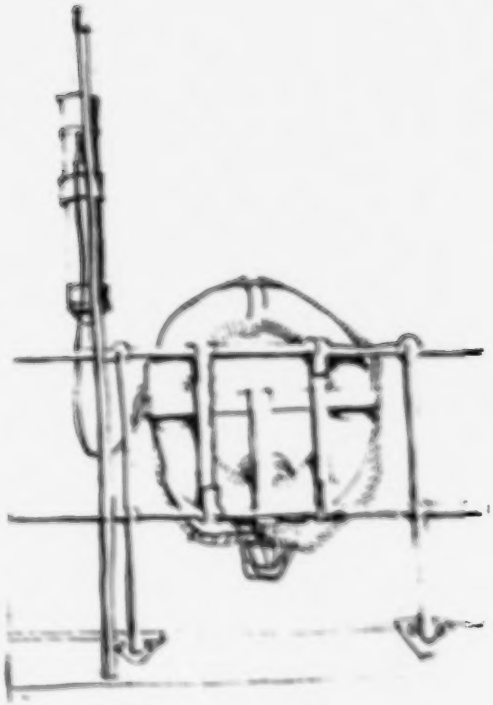
DECK HOIST

USED FOR GANG-WAY, LOADING, AND OFFLOADING STORES AND EQUIPMENT

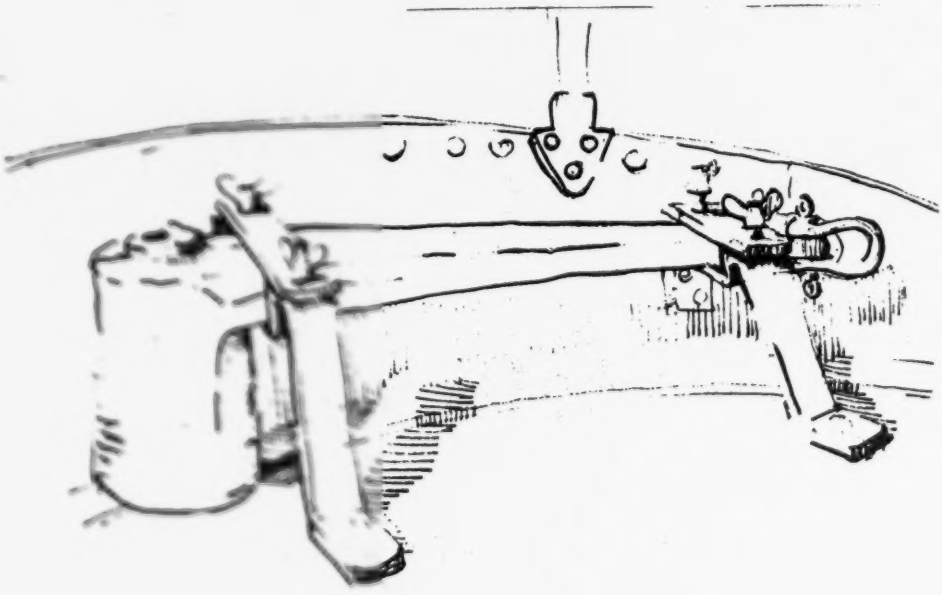




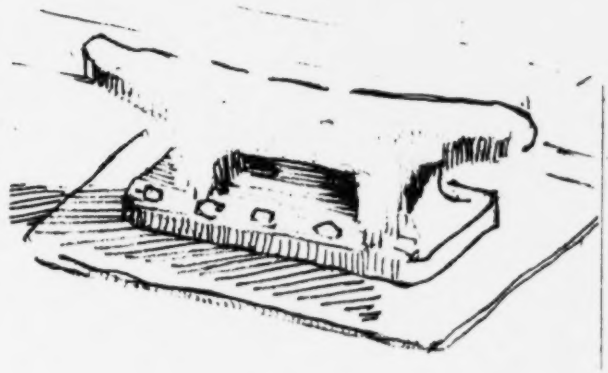
④ HATCH



⑤ LIFE BOUY WITH RESCUE LIGHT



⑥ RUDDER WRENCH



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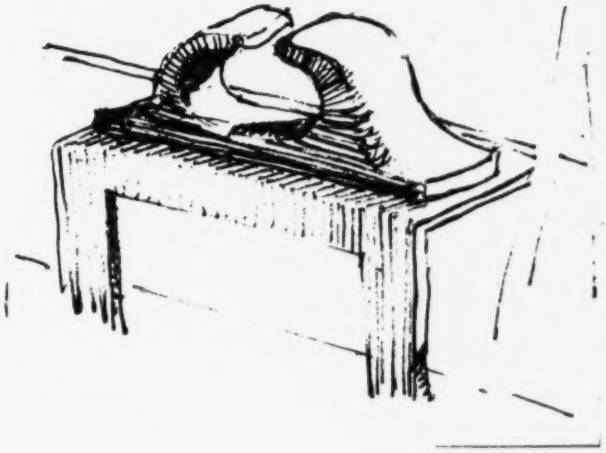
CLEAT
FOR THE SECURING OF LINES



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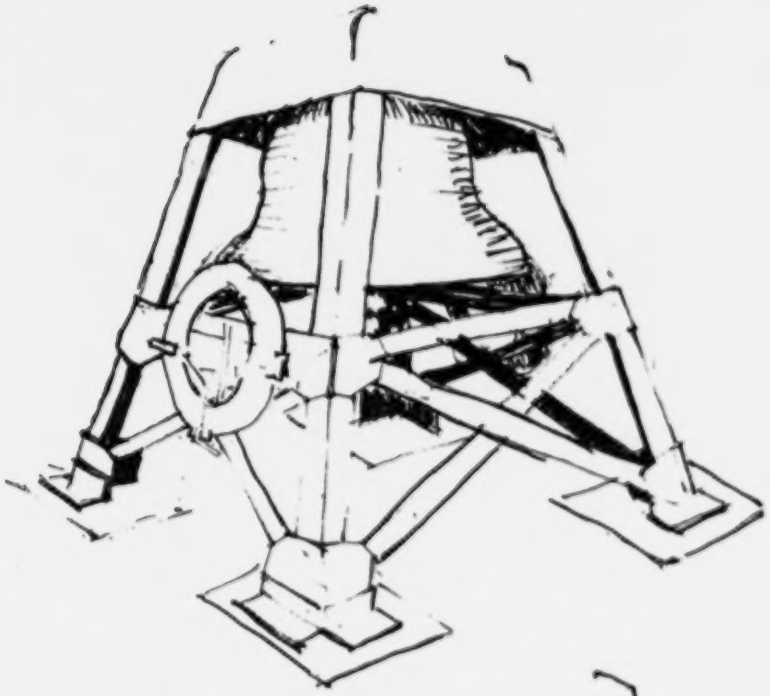
CHOCK
FOR THE PASSAGE OF LINES

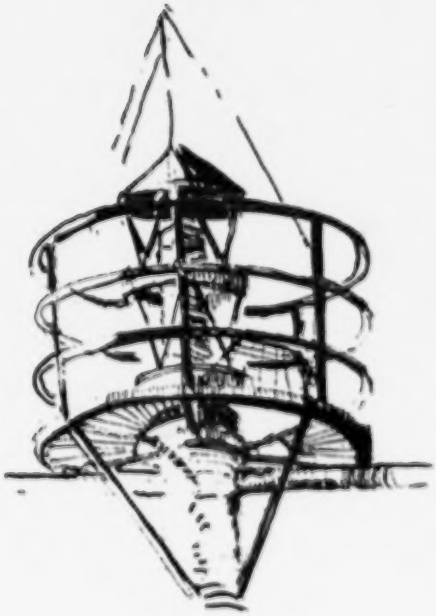
9

BITT ON SHIP
CALLED A BOLLARD ON SHORE
FOR THE SECURING OF MOORING LINES

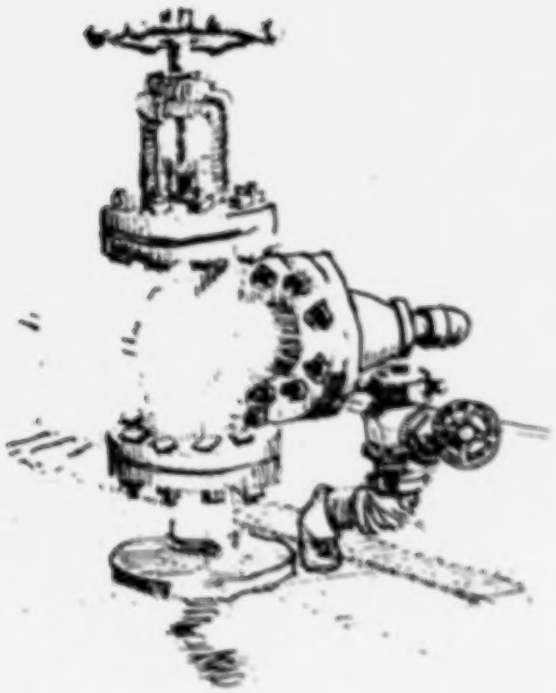


(10) BELL TOWER with RING BUOY

ANEMOMETER (11)
WIND SPEED INDICATOR

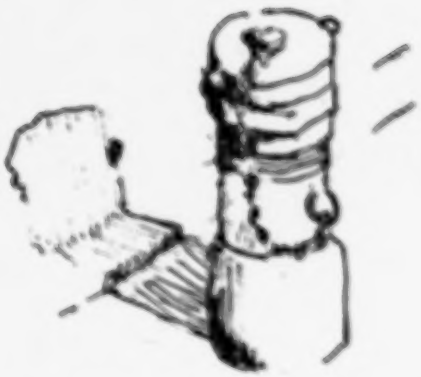


(12) BEACON



(13)
FUEL OIL &
LUB. OIL
INTAKES
YELLOW MARKINGS

POTABLE WATER (14)
INTAKE
BLUE MARKINGS



(15) EXHAUST VENT

(16)
PORTHOLE

FOR LIGHT & VENTILATION

(17) FIDDLEY VENT

II. UNDERWAY

STATION 1 - HISTORY OF THE POTOMAC

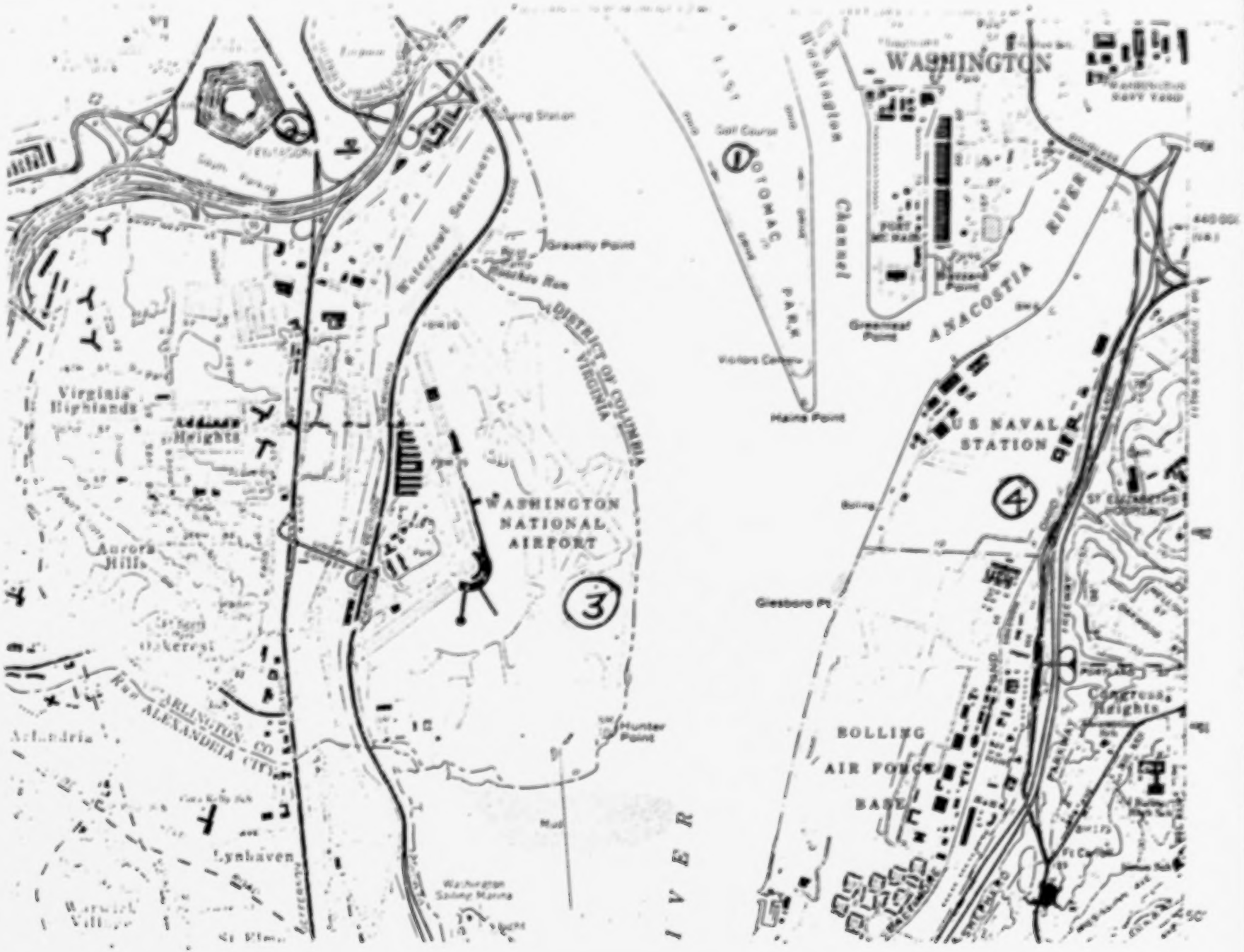
PURPOSE. At this station we want to increase the student's awareness of change and to focus particularly on the changes that have taken place in the Potomac River basin as a result of man's presence. Changes that affect us are not always negative; we must be aware of positive changes too. The student will examine both positive and negative changes while visiting the ship and in the "Special Sea and Anchor Detail" and "Dry Dock" portions of this manual.

INFORMATION AND ACTIVITIES. Upon arriving at the Lightship Chesapeake, the children will board the Wood-Duck (a 42-foot craft) for a trip to the tip of Hains Point where the Potomac and Anacostia Rivers and the Washington Channel converge. Many of the National Capital landmarks are visible from here. With the aid of a rough map on which these landmarks have been highlighted, the children will work with small hand compasses to try to determine their location in reference to the map.

This is also an excellent vantage point from which to discuss the historical development of the Potomac Watershed. The children will use older maps of the area which illustrate how aspects of the river have changed as man's use of it has changed. We'll look at a navigation chart of the same area, and one of the things the children will notice is that the landmarks they just identified are the same ones a ship's captain must rely on as aids to navigation.

ACTIVITY #1. In today's world, events change so quickly that many of us become immune to the speed and scope of the progression of time. Have the class examine change in areas that they know:

- Watch the second hand of a clock or observe a cloud passing the school window.
- Log the changes at school from day to night, summer to winter. What about the construction or tearing down of other buildings in the area?
- Bulletin board project: use back issues of magazines to compare, through the advertisements, models of automobiles, clothes, and household gadgets.
- Send the students outside and have them prove that some living thing in their environment changes.
- Have each student select a quality about himself and record its change. Can they speed up or slow down the change? How would they like to change?
- Find the youngest and oldest thing inside the school or outdoors; discuss how age is described.
- Ask the students to find something in their environment that is increasing in number. Can they prove it?


WASHINGTON
Washington Channel
POTOMAC PARK
ANACOSTIA RIVER
Golf Course
Greenleaf Point
Visitors Center
Maine Point
U S NAVAL STATION
Boiling
Giesboro Pt
Congress Heights
BOLLING AIR FORCE BASE
Gravelly Point
Roaches Run
DISTRICT OF COLUMBIA
VIRGINIA
Waterfowl Sanctuary
Virginia Highlands
Arlington Heights
Aurora Hills
WASHINGTON NATIONAL AIRPORT
Hunter Point
Mud
Lynhaven
Washington Sailing Marina
Four Mile Run
ARLINGTON CO
ALEXANDRIA CITY
Alexandria
Warwick Village
RIVER
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ALEXANDRIA
COLUMBIA
POTOMAC RIVER
ANACOSTIA RIVER
Fort Myer
Arlington National Cemetery
Jackson City Station
Fort Ringgold Station
Bailey's Cross Roads
Long Bridge
Aqueduct Bridge
Three Sisters
Rosslyn
Arlington Mill
Chesapeake and Ohio Canal
Baltimore and Ohio R.R.
Bladensburg
Benning
Good Hope
Anacostia
Uniontown
Congressional Cemetery
Alexandria
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ACTIVITY #2. Demonstrate the mechanics of a compass by magnetizing a needle (rub it on a magnet) and then floating it in a beaker of water. Since ships have no street maps to guide them, they are dependent on their compass and charts for navigation. What types of things must a captain know when "driving" his ship? Consider depth of water, current, and wind. There are more suggestions for mapwork in "Dry Dock" page 20.

ACTIVITY #3. The Washington, D. C. Metropolitan Area is one of the fastest growing in the nation. Attached are two maps, the first made in 1885, the second in 1965. Four examples of change are indicated on the maps; compare them and then discuss how they have changed even more in the past few years:

1. East Potomac Park in 1885 was a marsh area normally housing frogs, snails, turtles, cattails and ducks. Today there are a golf course, swimming pool and visitor center, as well as walkways, a sea-wall and even the Lightship mooring. How have these changes affected the ecology of the Potomac?

2. Examine the area that is now the location of the Pentagon, I-95, and Crystal City. In 1885, it was moderately marshy and the Chesapeake and Ohio Canal was the best means for transportation. The marsh has been filled in, and the canal has given way to what other means of transportation?

3. If National Airport had been built in 1885, it would be sitting in the river. In order to accommodate modern air traffic and automobiles, the area was filled in, leveled and paved. How did paving affect the natural watershed of the Potomac River? Does the noise of the airport have any effect on your daily life?

4. The U.S. Naval Air Station was also once a part of the Anacostia River. What changes had to be made in the river to allow for man's inventions?

A good way to illustrate the different ways of looking at an area is to compare maps of the same area made for different purposes, e.g. a land surveyor, a geologist, the present and the proposed Metro system would each have maps showing striking differences. They may not even be readable outside a specialized audience.

ACTIVITY #4. More map ideas. Have each student draw a map showing the route he takes to get to school. However, instead of conventional lines for streets, have them use words or pictures to express the various landmarks and routes they take. They may want to express the shortest or the safest or the most pleasant route. If you have a camera at your disposal, do the same project using only photos to describe the route. Ask the students to make a map that shows how they felt when traveling this particular way; what colors or words describe their experience?

By using tracing paper and a conte crayon or charcoal, construct a map of the different textures along a particular street: bricks in

a building, sidewalks, license plates, signs. Gather different pieces of that environment (weeds, gravel, sand, leaves, bits of trash) and make a collage depicting the journey.

STATION 2 - SOURCES OF WATER

(The Hydrologic Cycle and Weather)

PURPOSE. Students are often surprised when they realize that the world's water supply is finite, and that within only a few years we will reach the limits of our usable water supply. In discussing the water cycle, our aim is to help students discover where water comes from and what different forms it takes at various stages of its cycle. Because temperature variation and weather patterns have so great an influence on the distribution of water, we will spend some time examining weather-monitoring instruments, and we will discuss how they are used to forecast weather conditions.

INFORMATION AND ACTIVITIES. Perhaps no environmental factor has more bearing on our day-to-day lives than the weather--that thing that everyone talks about and, at best, only second guesses. To discuss weather-monitoring devices, it is necessary to be familiar with the concepts of air temperature, air pressure, air moisture, and air motion. What are they? How are they measured? And how do changes in these factors indicate approaching changes in weather conditions. Your class will perhaps already know much about weather factors and instruments from television or from school. We have found that their understanding of the concept of working instruments improves when they themselves have had a hand in their construction.

ACTIVITY #1. By constructing and using simple instruments, students will be able to observe and measure various weather phenomena. They will become more acutely aware of many different factors making up "weather" and how they interrelate as weather changes or remains stable.

A. Air temperature. What is a thermometer and how does one read it? You may want to buy an inexpensive thermometer, locate one at school, or ask students to bring them from home. Instructions for building homemade thermometers are available in the Boy Scout Handbook or a marvelous little paperback called Weathercraft (see bibliography on page 38). Should no thermometer be available, students can observe the principle of the thermometer in this very simple experiment:

Partially fill a glass tube with red or blue alcohol (use food coloring) and then seal it. If possible, have one for each child or group of three or four children. You will need two plastic or glass tumblers for each child (or group). Fill the tumblers half full, one with cold and the other with hot water. Ask the children to submerge the bulb of the

sealed tube in the cold water and keep it there for a count of 60. Then remove the tube from the cold water and submerge it in the hot water, again holding for a count of 60. What happens to the liquid as it expands and contracts?

B. Air Pressure. Air has weight and mass, and it exerts pressure on the earth which we can measure with a barometer. Accurate pressure readings can best be obtained with a 'store bought' barometer, but for telling changes in air pressure--all that is really needed for predicting weather pattern changes--a very simple barometer can be made.

You will need:

1 large bottle with a long neck
(a wine bottle is just right)
1 glass tube, about the size of a straw
1 cork or rubber stopper
water
food coloring

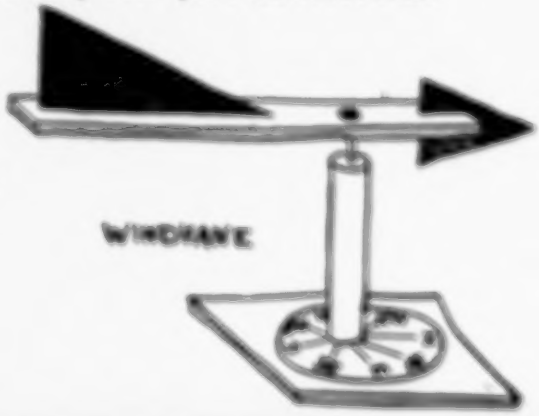
Directions:

1. Fill bottle 1/3 full of colored water.
2. Mark glass tube at one-inch intervals from one to six up from the bottom.
3. Put glass tube through the stopper and suspend it in the bottle stopping about one inch from the bottom.
4. Use the telephone weather report or another barometer to calibrate known pressure readings. Watch changes in pressure, remembering that dropping pressure predicts inclement weather.

C. Air Motion. Weather vanes and anemometers are instruments that help us determine the direction and velocity of the wind. Weathervanes are designed to point out the direction from which the wind is coming. Often you may be able to estimate wind direction or relative speed by the way trees blow or smoke drifts. Following are directions for making a weathervane and an anemometer; following them is an adaptation of the Beaufort Wind Force Scale to help with your calculations.

For a WINDVANE you will need:

2 triangles of any stiff material
1 stick 15 to 18 inches long
2 nails
1 piece of broom handle about 18" long
1 piece of board about 1 foot square

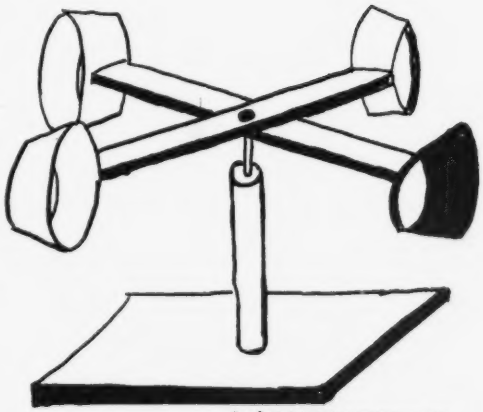


Directions:

1. Glue triangles on stick to make 'arrow.'
2. Find balance point on 'arrow' and drive nail through at that point.
3. Drive nail into one end of broom handle.
4. Mark off a 360° compass rose on board.
5. Nail broom handle to center of board.
6. Use in combination with anemometer to determine speed and direction of the wind.

For an ANEMOMETER you will need:

4 paper cups of 2 rubber balls
2 sticks about 12" to 15" long
2 nails
1 piece of broom handle about 18" long
1 piece of board about one foot square



ANEMOMETER

Directions:

1. Cut top off cups to make them 2" high, or cut balls in half.
2. Glue (or nail) cups to end of sticks so that cups face opposite directions.
3. Drive nail through center of both sticks to form a "Plus" shape.
4. Nail the "plus" into one end of broom handle.
5. Nail other end of broom handle to board.
6. Paint one of the cups black.

To read the anemometer: Using the black cup as a guide, count the number of turns in 30 seconds. Divide this figure by five to find the wind speed in miles per hour.

D. Air moisture: Although the concept of air moisture may not be easy to grasp, we are all aware when a change in the humidity affects our hair or makes it harder to breathe. While on the Lightship, students will take relative humidity readings using wet and dry bulb thermometers. A table for determining the relative humidity by this method is in the "Dry Dock" section of this manual on p. 39. Both the table and the instructions for these simple instruments are compliments of the Naval Weather Service. Students who have constructed these instruments report that they work very well. To calibrate them, students will have to telephone the National Weather Bureau for readings.

E. Rain. Rain is measured in terms of the depth of the sheet or layer it would make if none drained off or was otherwise lost. Rain can be measured in many ways but usually a large funnel and narrow receptacle are used. Directions and illustration for making a rain gauge are on the next page.

To make a RAIN GAUGE you will need:

1 large juice can
1 olive jar 7 3/4" high and 6½" in circumference
1 funnel with 4" wide mouth
3 handfulls of small stones

Directions:

1. Mark olive jar at ¼" intervals.
2. Place olive jar in can with stones around the base for stability.
3. Place funnel in top of can with spout in olive jar.
4. Place gauge in an open area and wait for rain.
5. Each ¼" of water in the olive jar indicates 1" of rainfall.

RAIN GAUGE

ACTIVITY #2. Take the thermometer out to the school yard and record the atmospheric temperature for one week. From the data recorded during the week, make a line or bar graph from which it should be easy to report the highest and lowest temperatures during the week. How might air pollution affect the weather or the temperature?

ACTIVITY #3. Because there are 180 Fahrenheit degrees and 100 Centigrade degrees between the freezing and boiling points of water, 1° F is equal to 100/180 or 5/9 C; and 1° C is equal to 180/100 or 9/5 F. Furthermore, because 0 on the Centigrade scale is the same as 32 on the Fahrenheit scale, we must always subtract 32° when converting Fahrenheit to Centigrade, and always add 32° when converting from Centigrade to Fahrenheit.

To convert from Fahrenheit to Centigrade, subtract 32 from the F reading and multiply the result by 5/9.

$$C = (F-32) \times 5/9$$

To convert Centigrade to Fahrenheit, multiply the C reading by 9/5 and add 32.

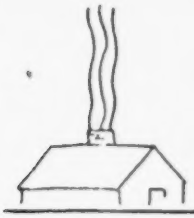
$$F = 9/5C + 32$$

Vocabulary for the Sources of Weather station:

Weather	Air Pressure	Relative Humidity	Cycle
Climate	Barometer	Cirrus	Precipitation
Temperature	Humidity	Stratus	Condensation
Thermometer	Hygrometer	Cumulus	Evaporation
Bore	Bulb	Centigrade	Contract
Expand	Fahrenheit		

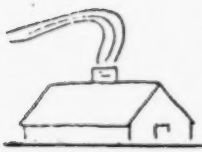
WIND FORCE SCALE

Adapted from the Beaufort Scale



Less than 1 mile per hour.
Smoke rises straight up.
Sea is very smooth.

0 Calm



1-3 miles per hour.
Smoke drifts; weather vanes still.
Sea has very small waves but no foam crests.

1 Light Air

4-7 miles per hour.
Leaves rustle; flags stir.
Wind felt on face.
Waves short but visible.

2 Slight Breeze

8-12 miles per hour.
Leaves and small twigs in motion.
Crests of waves may break, may have glassy foam.

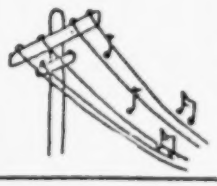
3 Gentle Breeze

13-18 miles per hour.
Dust, dry leaves and paper raised; small branches move.
Waves larger; many whitecaps.

4 Moderate Breeze

19-24 miles per hour.
Flags ripple; small leafy trees sway.
Can see waves with white foaming crests.

5 Fresh Breeze



25-31 miles per hour.
Flags beat; large branches in motion; telephone wires whistle.
Larger waves with foaming crests.

6 Strong Breeze

32-38 miles per hour.
Flags are extended; whole trees in motion; walking against wind difficult. Foam begins to blow. at sea.

7 Moderate Gale

39-46 miles per hour.
Twigs break off trees; walking is hindered.
Waves larger; foam blown in thick streaks.

8 Fresh Gale

47-54 miles per hour
Slight building damage.
Waves larger still, with thick foam.

9 Strong Gale

55-63 miles per hour.
Trees uprooted; much damage.
High waves with great crests overhanging and foam patches.

10 Whole GAle

64-72 miles per hour.
Very rare; much general damage.
Ships may be hidden in troughs of waves; air filled with spray.

11 Storm

Over 73 miles per hour.
Hurricane; devastation.

12 Hurricane

MAS #23

With thanks to the Massachusetts Audubon Society. Also used Wonder Book of Weather and Exploring the Weather.

STATION 3 - THE AQUARIUM

(Life in the Potomac)

PURPOSE. One of the most popular places aboard the Lightship is the crew's rec area which has been converted to an aquarium depicting life in the Potomac (yes, Virginia, there are fish living in the Potomac!). Because some fish have difficulty adapting to an aquarium environment, specimens will vary during the year. Students will see predator and scavenger specimens and have an opportunity to observe surface, middle and bottom dwellers. Making its debut in the summer of 1973 is a 250-gallon saltwater aquarium in which some inhabitants of the Chesapeake Bay are displayed.

INFORMATION AND ACTIVITIES. The effect of pollution upon the inhabitants of an aquatic environment is covered in the Water Content and Analysis section of this manual and at that station aboard the ship. Your students should become familiar with these additional definitions and concepts in preparation for their visit to the aquarium:

Plankton. The name (derived from a Greek word meaning "to wander") of small, often microscopic plant and animal organisms that float or drift in the ocean or in bodies of fresh water. We will see that these tiny members of the ecology can have an enormous effect on an aquatic environment.

Oxygen. The most abundant chemical element and the most essential to life, it is a tasteless, odorless, colorless gas found in the atmosphere, in water, and combined with other elements in many materials and living creatures.

Photosynthesis and Respiration. Together they are a kind of balancing act in nature. In photosynthesis, plants take in water and carbon dioxide from the air. By the sun's action on chlorophyll in the plant, the water and carbon dioxide form carbohydrates and release oxygen back to the atmosphere. In an aquatic environment, plankton play a role similar to that of plants in a terrestrial system: taking in water and carbon dioxide and releasing oxygen.

Respiration is the opposite process by which living organisms take in oxygen and release water and carbon dioxide to the atmosphere. Humans describe this function as 'breathing.'

Food Chain and Food Web describe the process of energy transfer through the various levels of aquatic and terrestrial communities. The process begins with photosynthesis in sunlight by plants and plankton which are the primary food of plant eaters (herbivores) which in turn are eaten by meat eaters (carnivores). There is substantial loss of energy as it transfers from one level to the next, influencing, among other things, population size. For example, there are more plant

eaters than animal eaters, and there are more animals that eat plants than meat eaters that eat other carnivores. There is much dependence throughout the chain, and anything affecting one portion has an effect on all other parts. The web concept can be seen when an organism from one food chain feeds upon an organism from another. Remember Johnathan Livingston Seagull's search for a more efficient method of catching fish? The food chain cannot be termed a "cycle" because some of the energy of the chain is transferred to waste products and dead plant and animal material. These products support the decomposer community. (See the Food Web Game in the "Dry Dock" section, p. 33 .)

Watershed refers to the area drained by a river or river system.

Niche is a term that takes in the physical space and location of an organism and the part the organism plays in the life of its community. A niche is what the organism does and how it interacts with other living things. A useful analogy is to think of a habitat as an organism's "address" and a niche as its "job."

Biome. All the plants and animals that make up a biological community.

Ecosystem. A place where biomes live; a community of living and nonliving things in an interacting system.

Pollution occurs when anything is introduced into an ecosystem that upsets the natural balance of that system.

ACTIVITY #1. To help your students understand the concepts of community and community relationships, we strongly suggest a class visit to the National Aquarium located in the basement of the Commerce Department Building at 14th and Constitution Avenue, N. W. The aquarium houses over 2000 specimens of both freshwater and marine life (including babies and tiny invertebrates) from all over the world. Some exhibits represent natural environments in appearance and water condition, while others illustrate biological concepts and principles.

Dried specimens available for free loan in "teaching boxes" for the classroom include a set of shark jaws, pieces of coral, shells, natural sponges, and dried fish. Most of these specimens are on display at the aquarium. Boxes may be checked out for three-day periods and must be picked up and returned by the teacher. Lesson plans on various aspects of the aquatic world, background information, "how to" sheets, art lessons, poems, questions, etc. are available in the aquarium office. If your class is larger than 30 students, it would be best to notify the Aquarium before your visit. You will probably find it useful to visit the Aquarium yourself before trying to tackle it with your class. For additional information, contact Alan Levitt, Education Section, National Aquarium. His phone number is 967-2826.

ACTIVITY #2. Have your students decide which food chains they fit into and at what levels. Diagram them. Now ask the students to assume the roles of different animals; they must decide if they are predator or scavenger, the type of environment they inhabit, their main source of food and how it is found. Do they have to be careful of their movements so they do not become dinner for whatever is above them in the chain? Diagram the different roles. Write and act a play.

ACTIVITY #3. A "community" is the interrelated aggregate of plant and animal populations in an area, while a "population" is the total number of individuals of one species within that area.

In your community find indirect evidence of a population of something. Express it in writing in which you use no adjectives.

Find indications that a particular population should be reduced (for example ants, beetles, rats, automobiles, crowded buses).

List 10 kinds of indirect evidence of populations.

In your community observe two things, one of which is responsible for the other.

ACTIVITY #4. Using the definitions of a community and a population, trace the food chain of a city like Washington, D. C. Where does your food come from? What processes must it go through before it is marketed to you? What are some differences between, say, the Eastern Market and a Safeway? What constitutes the decomposer community?

STATION 4 - WATER CONTENT AND ANALYSIS

(Lab Work)

PURPOSE. The Potomac and Anacostia Rivers are polluted. We cannot swim in them; we cannot drink the (untreated) water; and we really should not eat any of the fish caught in either river. However, in spite of the problems, both rivers are still vital and contain numerous plant and animal populations. At this station we will study the living and nonliving content of these rivers. We will test for the presence and amounts of nutrients (phosphates, nitrates, detergents) in river water, and we will try to look at some of the microscopic organisms which inhabit the Potomac Watershed.

INFORMATION AND ACTIVITIES. In order that the lab work be meaningful to your students, we suggest that you discuss the following definitions and concepts with them. You will recognize how closely related they are to both the lab and aquarium work.

EUTROPHICATION means literally "enrichment" and refers to an increase of nutrients which encourage plant growth, especiallv in a body of water. A eutrophic or well nourished lake is one with large amounts of algae and other sources of organic material. Eutrophication also describes the aging process of a body of water, during which plants become abundant and animals supported by the plants grow in number. The increased organic populations result in increased amounts of dead matter settling to the bottom of the pond or lake and gradually reducing its depth. After many years of filling by this process, it becomes a shallow, dense marsh, and still later a meadow.

CULTURAL EUTROPHICATION is eutrophication caused by man.

NUTRIENTS are food. Two nutrients normally found in water are phosphates and nitrates. Both are necessary to the health of the aquatic environment. However too much phosphate or nitrate leads to cultural eutrophication or excessive growth of algae and plankton in the water. The mat-like surface scum of slow-moving water is actually an algae bloom. The scum prevents sunlight from reaching underwater plantlife, reducing and finally halting photosynthesis and the production of exygen. With the increase in algae and plankton populations, there is of course an increase in the number of these dead organisms, and their decomposition by bacteria results in a further loss of oxygen in the environment. Fish and other aquatic life dependent on oxygen either leave the area or suffocate.

How do these excessive amounts of nutrients get in our rivers and lakes? Man dumps untreated industrial and domestic wastes, including high-phosphate detergents, directly in the water. He uses artificial fertilizers for crops, golf courses and lawns, and eventually their ingredients find their way to rivers. His sloppy construction of roads and housing developments erodes the soil and adds soil nutrients to the water. Man in his greed and carelessness is killing the resources he needs most to live.

TURBIDITY is the muddy or cloudy quality of water usually caused by silt (suspended particles of soil or sand), dead plant fragments, or living organisms such as plankton. Under turbid conditions, light will not penetrate the water's surface very far and the depth of water that can support life will be reduced. Some organisms in turbid water experience a buildup of particles on gills or other areas.

The Potomac's greatest and perhaps most obvious problem is that it is a very dirty river. Last year, the Potomac carried to the ocean enough sediment to fill a square block to a height of 171 feet. One expert has prophesied that the present rate of siltation will allow us to walk on the Potomac River by the year 2000.

ACTIVITY #1. The oxygen depletion stage of eutrophication can be observed in this simple experiment:

You will need two clear, colorless glass quart or gallon jars of the same size and shape. Fill both with water to a point one inch from the top. While stirring, add an equal number of drops of a methylene blue solution to each jar of water. (Methylene blue is an antiseptic often used to treat fish infections; it is inexpensive and available at any pet store.) The color should be the same in both jars.

Cut up three apple cores (or a similar quantity of orange skins, carrot tops, banana peels, or any other plant tissue). Mix the plant material with two tablespoons of soil and wrap the mixture in a piece of cotton cloth the size of a large handkerchief. Tie it tightly with string, weight it with a stone, and let it sink to the bottom of one of the jars. Cover both jars with plates or aluminum foil.

When bacteria begin to decompose the dead organic tissue, they will use up the oxygen dissolved in the water. Within a few days the solution in the jar with the tissue will lose its color because methylene blue is blue only in the presence of oxygen. As bacteria use up the supply of dissolved oxygen, the blue disappears from the experimental jar while the solution in the control jar retains its color.

The experimental jar is like a pond or lake where eutrophication has occurred and there is no longer enough oxygen for fish and other animals to survive. (Thank you, Professor A. Schatz of Temple University.)

ACTIVITY #2. Back in the "olden days" when people wanted to wash their dishes or laundry, they used soap. If their water supply contained few mineral salts (soft water), soap proved to be a very effective cleaning agent; if however the water was rich in minerals (hard water), there were problems of sticky residues, scum or curds that formed during the rinsing process. Whatever people thought of its performance as a cleanser, soap did a great disappearing act. Being biodegradable, it broke down into its component organic parts and was rather easily absorbed by nature, causing little or no unbalance or damage to the environment.

Times have changed and soaps have been largely replaced by detergents, which are nonorganic cleansers that do a superior job of cleaning in either soft or hard water without producing a scum. They are widely used for building and industrial maintenance and all kinds of home cleaning tasks. Commercial advertising has convinced people that whiter, brighter laundry and sparkling dishes are essential to civilized life--and possible only with detergents. As a result we use about 20 pounds of detergent per person per year for an annual total of 4 billion pounds.

Detergents however contain phosphates, a major cause of water pollution discussed earlier in this section. How can we keep the convenience and effectiveness of detergents and still avoid the dangers caused by

excessive phosphates in our waterways? One answer is to return to using soap or to eliminate the phosphates in detergents. Another is to use less than the 'recommended' amount of detergent in washing operations. These solutions mean going back to the days of more work for less cleaning power.

It is possible although expensive to remove phosphates from waste water by treating it with lime, aluminum, or iron salts that combine with the phosphates to form insoluble particles. These are easily removed from the water before it enters our waterways. Waste treatment technology is available and, in spite of its expense, may be the best answer to the phosphate pollution problem.

A number of activities will aid your class in studying the use, composition and effects of detergents.

Collect ten bottles or jars of the same size; water; eight samples of different detergents and one sample of soap, all with labels; measuring spoons; and nine needles.

Fill the containers with equal amounts of water. Label each container with the name of a detergent or soap and, using the directions on the label, determine how much cleanser should go in each of nine bottles. Add nothing to the tenth bottle and use it as a control for the excercise.

Stir each container until the contents are thoroughly mixed. Make observations about each solution immediately after stirring, 15 minutes later, and 15 minutes after that. Write down your observations using terms such as cloudy, murky, clear, dissolved, sudsy etc. One possible format for recording observations is suggested below.

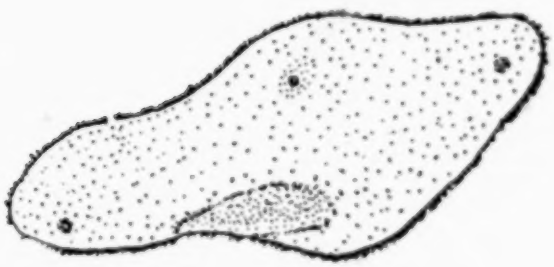
Name of Sample	Color After Stirring	Color After 15 Minutes	Color After 30 Minutes

Carefully place a needle on top of the solution in eacn container and observe what happens. How do these results relate to the cleansing power of detergents and soap?

Put a dirty cloth in each container and speculate about "cleaning power."

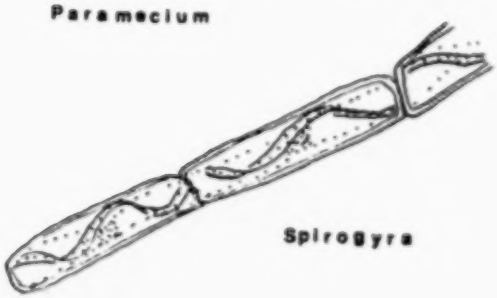
ACTIVITY #3. Start with ten clean jars filled with equal amounts of water. Label the jars with the names of ten different detergents. Add detergent in small measured amounts, stirring each addition thoroughly. Determine how much detergent can be added to each jar before the solutions show a change. Record the results on a chart.

ACTIVITY #4. Study these drawings of freshwater organisms so you will be able to recognize them when examining water under the mocroscope aboard ship.

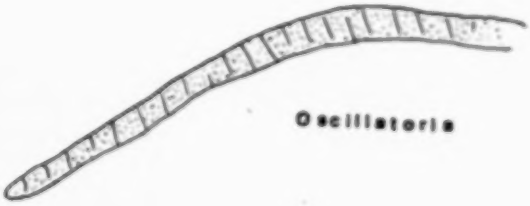


Paramecium

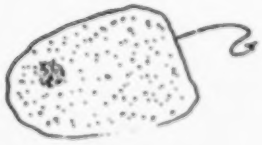
Pediastrum



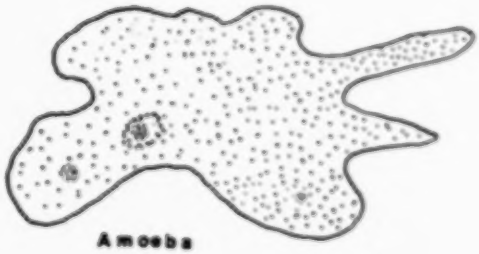
Spirogyra



Oscillatoria

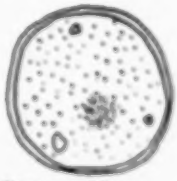


Euglena



Amoeba

Closterium



Chlorella

ACTIVITY #5. For a composition assignment, ask the students to take George Washington on a tour of 20th-century Washington, D. C. and to explain to him how the river is affected by the Washington area's rapidly growing population.

ACTIVITY #6. Use a string painting to express the feelings of a fish that lives in the Potomac.

ACTIVITY #7. Suggested discussion topics and questions:

1. How do detergents get into rivers?

2. When large quantities of phosphate or nitrate are in pond or lake water, microscopic plants such as algae multip. y so rapidly that they may clog up the pond or lake. Algae live only a few days; do you know what happens to the dead algae?

3. If a large quantity of dead algae accumulate, what do you think happens to the number of bacteria?

4. Bacteria, like most organisms, require oxygen. In a dying pond, where will the bacteria get oxygen once the supply dissolved in the water has been used up?

5. What occurs at the bottom of a lake when the remains of billions of decomposed algae accumulate there?

III. DRY DOCK

SOCIAL STUDIES

Discuss with your students the cultural backgrounds of people living within different geographic regions such as desert, mountain, and jungle. How do they depend on their environment for survival? What particular needs do they depend on it for? Can they subsist in that environment without having to import or introduce new elements into that region?

ENCYCLOPEDIA WORK

Send your students to the encyclopedia or other library reference books for information on ships, shipping, the Anacostia and Potomac Rivers, and the District of Columbia. Give groups of students each a different aspect of the community to research, e.g. government, industry, social structure, trade, arts and crafts. Then combine their findings to get a picture of the entire community or region. Have the students write, direct and perform in a play, puppet show, commercial, or "You are There" dramatization of a day in the life of this community. Using the same community, change the scene to 100 years earlier and then 100 years later.

MAP WORK

See if your school library has old maps of the Chesapeake Bay and Potomac River and its tributaries. A small one is provided in the Underway Section following page 6. Locate old Indian villages, the Georgetown wharves, and the C. and O. Canal. Have students speculate on the future development of the Georgetown waterfront. Should there be "people places" such as houses and shops, or industrial concerns such as are now there? How will different kinds of development affect the river? Two good resource places for this excercise are the National Geographic Society at 17th and M Streets, N. W. and the GSA Building at 19th and F Streets, N. W., which houses the Map Section of the Office of Geological Survey.

Locate the Potomac River on the map. Try to determine how many miles of it flow into the Virginia, Maryland and D. C. area. How large an area does its watershed cover? How many states? Who owns the water in the Potomac River? Find and interpret statistical maps or graphs showing population growth along this region from the time of the Indians, to the period of the colonization of Jamestown, and on to the present day. What industries were prosperous during the past 300 years? Why

have they increased or decreased in importance? Analyze and explain your findings. Speculate about what a visitor will find along the Potomac in the year 2000.

Compare a recent navigation chart of the Potomac River with one approximately 20 years old. From the depths given, can you draw a profile of the river's bed and how it has changed over the years? Is the prophecy true that by the year 2000 we will be able to walk across the Potomac?

Study the concept of waste; what are the savings and the costs of reusing waste materials. Send the students to discover examples of waste in our society. How many things can we purchase that are meant to be used only once? Ask them to cite examples of over-packaging products. They may observe cardboard-wrapped carryout hamburgers and individually wrapped cheese slices.

Set up a polling station on a major commuter artery into the District. How many cars with just one person go by? Have the students compute the cost of traveling from their school to another place by bus, by car, by metro, walking, and biking.

TRIPS

Visit the Potomac and Anacostia Rivers. Some interesting places are: National Airport, Jones Point, the Navy Yard, Blue Plains Sewage Treatment Plant, the recycling center at
and McMillan Reservoir and Treatment Station for Water at 2500 First Street, N. W. (off Michigan Avenue); call 282 2701 for reservations.

LANGUAGE ARTS ACTIVITIES

New and meaningful experiences often provide just the motivation needed for a student to master a writing or speaking skill. Good experiences cannot be held inside; they seek expression and both the experience and its expression are important parts of the child's growth.

Letter writing. Ask the students to express their feelings (either positive or negative) about visiting the Lightship in a friendly letter to a schoolmate.

In a letter to a schoolmate who is planning to visit the ship, have the student make specific suggestions about how the friend might enjoy the ship, special activities he should anticipate, or some of the different things he should be sure to see.

In a business letter to a government agency charged with pollution control, have the students express their ideas about the problems of the Potomac and possible solutions to them.

Have the class write a letter to the editor of a newspaper commenting on an article or editorial or the newspaper's lack of coverage of an environmental issue. Discuss in class what (in the government policy or in the newspaper) evoked their feelings or reactions. This activity will give pupils practice with the appropriate forms for business and friendly letters, as well as the experience of expressing a citizen opinion to a public body or forum. Each student should send his letter and share with the class any response he receives.

Spelling. Your students will hear and be able to use a great many new words such as pollution, eutrophication, barometer, spar, gunwale and others. Here are some ways to make them part of the student's everyday vocabulary available for reading, writing, speaking and hearing.

Acrostic: Write the correct word in front of its definition. When you finish, the first letter of each word read downward will spell a word connected to the ship.

Definitions	Key Words
_____ A freezer Box	Anchor
_____ The bathroom	Knot
_____ Motors to run the ship	Porthole
_____ For storing supplies	Head
_____ Used for docking	Exhaust
_____ A ship's window	Storage lockers
_____ A person to run the motor	Cold box
_____ Wind speed indicator	Engineer
_____ Measurement of Ship's speed	Anemometer
_____ Lets air out	Engines

The students, perhaps working in teams, can invent their own acrostics and challenge other teams.

Ask the class to list in alphabetical order:

Mess	Stern	Fiddley Vent	Indicator
Jute (hemp rope)	Oil	Bow	Windlass
Engine	Vent	Galley	Zee (Dutch sea)
Quarters	Crew	King buoy	Radio
Port	Head	Yeoman	Upstream
Tackle	Deck	Navy Anchor	Lockers
Anchor	Gunwale	Sheave	Leeward

Divide the class into several teams and have each team select a captain. The teacher gives each captain a word (see glossary on p. 6 of the students' booklet) on a flash card. The student must select enough members of his team to spell the word using one team member for each letter. At the captain's signal, the team spells its word by using their whole bodies to form the letters in sequence, or each pupil may make the sound of a particular object or speak as that person would speak. The captain might have each pupil say the sound of his letter in the word and, by speeding the sequence, the word will be heard almost as it is pronounced. The opposing team, without seeing the flashcard, must name the word being spelled and define it. This game can be expanded to charades-like activities with more complex phrases and concepts.

Poetry. First discuss with the class the sensations they experienced while aboard the ship and make a class list of the words and objects which most impressed them. Find words that rhyme and begin to write couplets.

Ask the students to write as many couplets as they can about their experience. List all the rhymes together as a poem in which each student has written one couplet. Arrange the poem as a choral reading or publish it in a class, school or city paper.

Use the library to find books with poetry on the weather, wind, and rain, and then write your own.

Discuss with your students ten different experiences on shipboard. Have each student write one word, not an adjective, describing that experience using a new line for each word. Have they written a poem?

Poetry. First discuss with the class the sensations they experienced while aboard the ship and make a class list of the words and objects which most impressed them. Find words that rhyme and begin to write couplets.

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Use the library to find books with poetry on the weather, wind, and rain, and then write your own.

Read the following quotation from Captain John Smith's 1608 description of part of the Potomac River. He describes fish that were

> ...lying so thicke with their heads aboue water, as for want of nets (our barge driuing amongst them) we attempted to catch them with a frying pan: which we found a bad instrument to catch fish with: neither better fish, more plenty, nor more variety for such fish, had any of us euer seene in any place so swimming in the water...*

*John Smith. The sext voyage. 1606 [1608]. To another part of Virginia in the True Travels, Adventures and Observations of Captaine John Smith, ..., Richmond: 1819, 2 vols., vol. 1, pp. 113-148.

Then have the students retell the story from the vantage point of one inanimate object mentioned in the story.

Earth

by John Hall Wheelock

"A planet doesn't explode of itself," said drily
The Martian Astronomer, gazing off into the air
"That they were able to do it is proof that highly
Intelligent beings must have been living there."

The Sun

by Michael Geelan

This burst
of joy;
This thrust
From space
Into the eye
and heart
This healing glow;
This gift
Too poor
And sick
This quick
Star-spanning
This part
Of life
So far away
That sweat
And tears
Are never far apart.

City Trees

by Edna St. Vincent Millay

The trees along this city street,
Save for the traffic and the trains,
Would make a sound as thin and sweet
As trees in country lanes.

And people standing in their shade
Out of a shower, undoubtedly
Would hear such music as is made
Upon a country tree.

Oh, little leaves that are so dumb
Against the Shrieking city air,
I watch you when the wind has come,
I know what sound is there.

Haiku is a three-line verse form which originated in Japan in the 13th century. Authentic Haiku consists of three lines: Line 1 contains 5 syllables, line 2 has 7, and line 3 has 5, making a total of 17 syllables in all. You will notice that English translations generally do not follow this pattern.

Each poem includes the season, location and a reference to nature. The subject matter is simple, ordinary things. There is no rhyme and no need for any, because Japanese words end in vowels or 'n' sounds. There are few articles or pronouns; with only 17 syllables, there are none to waste. Thought is primary in Haiku, and the syllables are adjusted to fit the form. Here are some examples.

Departing spring
Hesitates
In the late cherry-blossoms

Buson

Simply trust
Do not the petals flutter down
Just like that?

Issa

The old pond:
A frog jumps in,
The sound of the water

Basho

If Haiku is too exotic, try your luck at "Word Cinquain." Strictly speaking, cinquain poetry is a five-line verse form in which each line has a designated number of syllables, 2, 4, 6, 8 and 2 respectively. In "word cinquain" the verse has five lines each with the designated number of words and constructed as follows:

1. _____

2. _____ _____

3. _____ _____ _____

4. _____ _____ _____ _____

5. _____

1. Use one word to name the the subject of the poem.
2. Use two words to describe #1.
3. Use three words to describe what #1 is doing.
4. Use four words to tell how you feel about #1.
5. Use a word that means the same as #1.

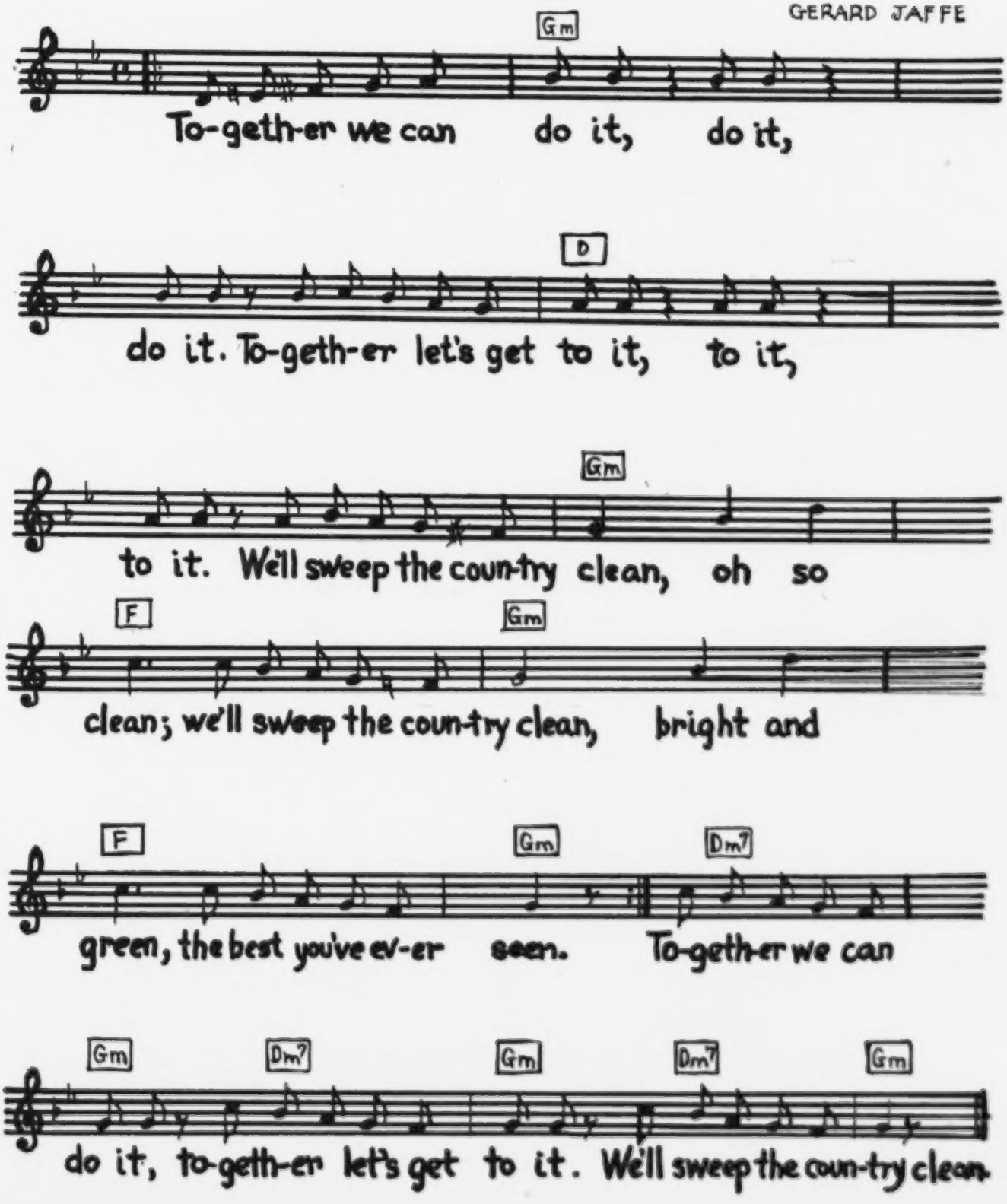
MUSIC

Your students are probably already singing many of the currently popular songs about the land, the beauty of the countryside, and ecology. Try introducing them to the sea chants or sailor work songs such as the "Earth Patrol Song" included in this packet. Have the children write their own songs and lead their classmates in singing them.

Try writing a song with sounds and home-made instruments. If you took a journey down the Potomac, you would pass many different sounds, people, trees, rocks, machinery. What sounds would you use to describe them? Listen to the Grand Canyon Suite or Stravinsky's Rite of Spring. Can you create the same sense of 'happening' as these composers were able to do?

THE EARTH PATROL SONG

GERARD JAFFE



DRAMA

Pantomime. Tell a story without words. Have the students assume the roles of trees, animals, Indians, settlers, the sun or the seasons; then express through movement the aging of that scene or the changing of the seasons. What characters are present? For how long? Does their behavior change by the season, with age, in different kinds of weather? Tell without words the tale of a fish trying to swim from his clear little tributary in West Virginia down to the Chesapeake Bay. What obstacles does he confront? Who are his friends, his enemies? Does he need glasses along the way to enable him to see beneath the dirty water?

Improvisation. Have each child become a part of a picture. In his role as cloud or tree, he must discover how to express his own nature and how to relate to the other parts of the picture. To bring the picture to life, the waves might roll, the ship heave, and the clouds move overhead. The only limit is the child's imagination. You could begin with a seascape; then try a scene the children know from their own neighborhood, from a walk by the river, or from the heart of the business district. How are the various roles (the air, cars, the tides, bits of debris, grass, and trees) affected by the seasons, by changes in the tide, by urban renewal, by a week of rain, or a week of smog?

Other ideas. Write a simple monologue of what the river might see as it journeys to the ocean. Students act out in pantomime the various influences on the river's journey while the story is narrated. Pantomime some of the poems in this manual, especially the ones about fish or animals.

ARTS AND CRAFTS ACTIVITIES

Knot tying. One of the first skills a sailor learns aboard ship is that of knot tying. From there it is a quick jump to macrame. Some of your students may have already made belts and wall-hangings from string. It can be fun to progress from string to one-inch rope using the same knots.

Things to make. Construct a mobile or collage of scenes aboard ship or seen through a porthole. For this you will need to research the

various fish, animals, birds and structures that surround the Potomac and Anacostia.

Construct a box movie to show scenery passing the portholes. A visit to the Corcoran or National Gallery will show the students samples of contemporary and traditional landscapes and seascapes. Construct a panorama or diorama of things that might go on aboard ship during a cruise.

Make a recycling display (remember the ones aboard the Lightship?) with found objects and pieces of trash. Research the process by which that material was originally made.

Introduce your students to origami as a craft for depicting water-related activities.

Creative arts. Use water colors to illustrate some of the things the students saw under the microscope. Extend it to include the water and sky. It is best to use the water color without drawing objects or outlines to express feelings or emotions. How would a watercolor of a polluted river differ from one of a clear stream or pool?

Make silk-screened or batik wall hangings using sea colors.

Try constructing book bindings and covers for your class's written materials.

Working with the three primary colors, develop a painting of a scene made of all shades and mixtures of these colors.

Have the students model in clay the feeling they had when the Wood-Duck pulled away from the pier.

How long has it been since you walked by the Potomac or by any stream or river? Did it make you happy, content, angry? Use a painting to express your feelings. How would a similar picture have looked 200 years ago; will there even be a river in the year 2000?

We encourage students not to make their experience aboard the Lightship Chesapeake purely a science-oriented one. The arts, literature, and emotions all play big parts in their learning and experiencing. If you are skilled in one area but not another, bring in a colleague or share this manual so another teacher can help you round out the student's learning experience.

Any of the work that your class completes that you would like to share with others may be displayed on the Lightship. Our space problem aboard ship means that exhibits cannot be permanent, but we would be delighted to have your students' work on display for at least a few weeks.

SCIENCE ACTIVITIES

Adaptation. What kind of adaptations are needed for a migration or move upstream by people (such as Indians) or by animals? Pretend you are an Indian moving up the river to find new land because the settlers have taken over your land. Pretend you are a fish moving upstream from an estuary toward the source of the river. Tell where you are going, what time of year it is, and what you look for and find. (See the paperback Troubled Waters by Daniel Mannix.)

Invent an animal or plant that is adapted to life in a particular aquatic or plant environment. Draw, color and name it; describe and explain the useful adaptations you gave it.

Life and chemical cycles. Pretend you are a molecule of carbon dioxide or oxygen or a drop of water, and tell your life story out loud, in a composition, or through a drawing--"the autobiography of a drop of water."

Make an original class mural showing the water cycle and the changes of the water as it travels from the mountains to the sea, from the sky to the earth and back again to the sky.

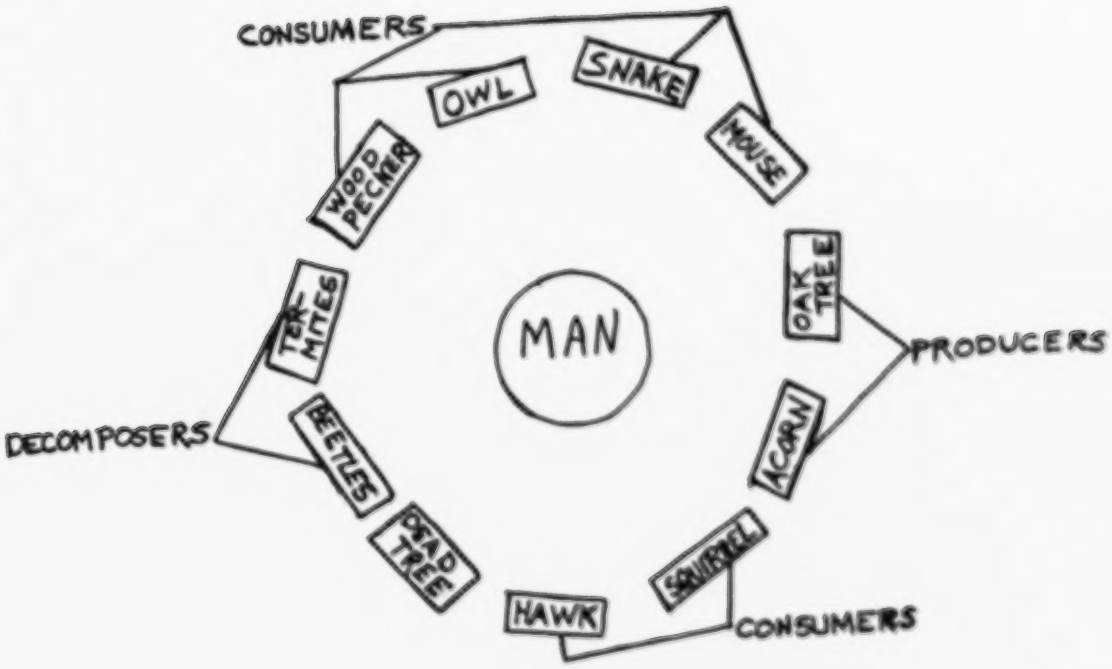
The transpiration phase of the water cycle can be demonstrated by placing a plastic bag or bell jar over a house plant and observing that moisture condenses on the inside of the covering.

The Food Chain Game can be played with 10 or 12 players. It will help the players discover how plants and animals form a food chain of producers, consumers, and decomposers, and what happens when the food chain is upset.

You will need only name cards (4" by 12") for each player.

Players form a circle as shown in the diagram on the next page. Each player is given a name card identifying him as a certain kind of animal or plant. The leader stands in the middle with the name card "man" and, starting with the plant, asks each player to hold hands with the player to his left. As each player joins the hand holding, ask the group how these two parts of the environment are connected or are dependent upon each other.

After all the players are holding hands, ask them to lean backwards as far as they can without falling over. Then without warning the leader rushes (carefully) between two players, breaking their handhold and tumbling the group over backwards. Now that the group has felt how the entire food chain becomes unbalanced when one link is broken, ask them to explain why and how this happens in the environment. You will probably want to form and break several food chains in this manner.



An oak tree produces acorns. A squirrel lives in the oak tree and eats acorns. A hawk catches the squirrel and eats it while perching by its nest in a dead tree. Bettles are beginning to eat (decompose) the dead tree. Termites continue to break down the wood further. A woodpecker eats the termites and beetles, and makes a hole in the tree. An owl uses the hole for a home and eats a snake which has eaten a mouse which has gnawed on the bark and acorns of the oak tree.

Communities in nature. Make a list of water biomes. Investigate the lives of some of the plants and animals found in each, and discover the adaptations they make to their environment. Compare a biome to a city or a nation.

"Niche" refers to the role an organism plays in its community. A niche includes the organism's habitat, food, predators, habits, contributions and withdrawals. Figure out the different niches of organisms living in the river. Compare them with those of people in an urban community. "Niche" in a city might include where people live, work, eat, play and study, as well as what goods and services they need and which ones they produce.

How many types of communities and micro-communities can you spot from your classroom window? They may be either natural or man-made.

What lives in each? Draw some of the inhabitants and make a "Food Web" showing the relationships of these organisms to each other.

Find out what chemicals are being used in your school, neighborhood or community. What is their effect on the water cycle and the environment?

Set up your own balanced aquarium in your classroom to study an aquatic environment. To set up a completely balanced system, you need only a few plants, a couple of snails, some water and a container. This is the simplest system and it can be self-sustaining. If you decide to complicate it by adding some fish, one inch of fish (excluding the tail) per gallon of water is a good guideline to follow. If it is balanced, your community should be able to survive for many months without any help from you.

Observe the life styles of the organisms in your aquarium and the effect of the environment on each of them. Observe and record the temperature in the aquarium at different times during the day. Use medicine droppers to take samples from each aquarium at different levels of depth and observe these samples under a microscope.

If the aquarium does not become balanced, try to find what is upsetting it. Change one thing at a time to see if you can clear up the stream. Use whatever happens to your aquatic system as a learning experience for the class.

There is a similar but less complicated balanced aquarium experiment you might like to try. For this you will need three equal-sized jars with lids, two snails, two underwater plants, some gravel and tap water that has stood for at least 24 hours.

Put gravel in the bottom of all three containers. Put plants in two of them. Put a snail in with one of the plants and the other snail in the jar without a plant. Seal all three containers. You will now have a jar with a plant, one with a snail, and one with a plant and a snail. Observe the three containers for at least ten days. Discuss what happens in each of the three containers.

For another interesting experiment you should collect water from several different sources. Place each sample of water in a different jar and label it. Try to grow the same kind of plant in each jar. Select the same kind and size of plant for all the jars in order to cut down on the reasons why the plants might grow differently. Treat all the jars the same way and observe what happens. Try adding a fish or snail to each of the jars and observe the results.

The Web of Life Game (for 7 to 15 players) illustrates how plants and animals (including man) are dependent upon each other and upon the environment (sun, air, water and soil) for survival through a "web" of inter-relationships, and what happens if the web is damaged.

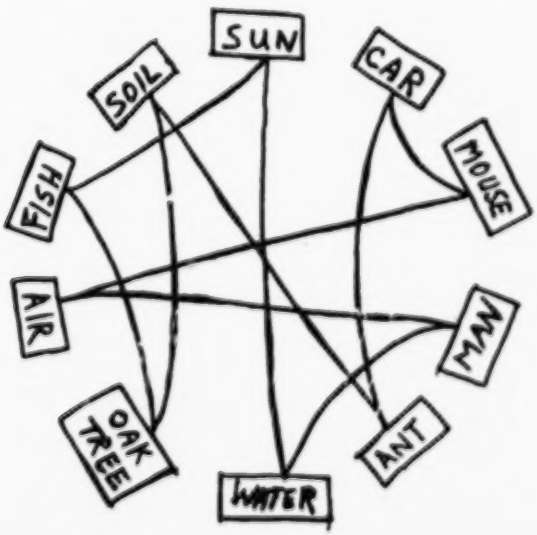
You will need: a ball of string
name cards, 4" x 12"
magic marker or crayon
scissors

How you play: Players form a circle. Each player is given a name card which identifies him as some part of the environment, such as the sun, air, water, soil, different plants and animals, and man; include also man-made things like cars, houses and factories.

The leader begins by asking the "sun" to hold the end of a string while the leader unwinds the string from one player to the next, crisscrossing back and forth across the circle. As each player is connected, ask the group why a connection is important in the environment; how, for example, is a tree connected to or dependent upon the sun; how is man connected to the tree and so on. Any two players can be connected. Be sure to unwind the string in one continuous strand; don't cut it after connecting the players.

After all players have been connected to at least one other player, the string will form a web which connects all the major parts of the environment as shown in the diagram below. Then the leader cuts the string between any two players and asks the group what will happen to the web of life now that a connection has been broken. Follow the cut string from one player to another showing how one broken strand can affect everything in the web since all are connected to one another. Eventually the connections lead back to the sun, the source of energy for all life.

This is a game that can be readily adjusted to the group's age and ability. The leader should be prepared for lively discussion and penetrating questions.



Communications. While we do not have a specific station on communications, you may want to try some activities related to it.

Discuss the best and poorest conductors of sound and radio waves. How do they travel? Consider solid, liquid and gaseus media.

Measure the amount of water in the air and relate it to the effectiveness of transmission of both sound and radio waves.

Using walkie-talkies, test communication over an open area such as a playground versus communication between classroom and playground. In which case were transmission and reception better? Try again on a stormy day and note the differences.

Consider the influence of weather changes on the effectiveness of the ship's bell, the diaphone, the radio telephone.

Make paper or cloth flags to show messages such as "Help Save Our Waters!"

Discuss the importance of a ground to an electrical system. Since a ship is always in the water, its communication apparatus is grounded directly to the water.

Other Investigations and Activities.

A Scavenger Hunt is great for helping people become aware of detail in nature. Depending on the size of the group, divide the participants into small groups of two or three. Give them their assignment list and ask them to return in about 20 minutes.

When all the groups have returned, let them share with the others what they found. Depending on the age and sophistication of the group, you may need to explain some items on the list, make changes and make up items of your own.

Find Evidence in Nature of the Following Phenomena

1. A simple machine
2. Three simple shapes
3. A sweet taste and a sour taste
4. A pleasant and an unpleasant smell
5. A trace from an animal
6. Three primary colors and two secondary colors
7. Three different textures
8. One sound
9. An example of nonbiodegradable litter being degraded
10. Something older than you are and something younger
11. A producer, a consumer, and a decomposer

Another activity is to study the bottom contour of the rivers we are studying. Discuss why this is important to the men on a ship, and how the type of bottom is important to organisms living in the river. You can use a terrarium to show the contours of the river bottom by color coding different depths.

Studying detergents: Ask the children to watch and make notes on the detergent commercials on television and to collect as many labels as they can from detergent containers. In class discuss similarities and differences among detergents. Then, using a bulletin board or large chart, have the students classify the labels by the purpose, content and physical state of the various detergents. For example:

Purposes: dishwashing, shampoos, bathing, laundry, household cleaning

Contents: low phosphate, no phosphate, high phosphate, enzyme

States: solid, liquid

Desalinization is the process of obtaining fresh water from salt water. (This section is brought to you by the National Fisheries Center and Aquarium.)

Man has long been experimenting with ways to convert sea water to fresh water. Being able to do this cheaply would solve many problems, especially for those countries where there is little rainfall.

Ocean water is composed of many minerals, the most prevalent of which is ordinary salt or sodium cloride. It is easy to remove salt and other minerals from ocean, but not so easy to save the salt-free water, as we shall soon see.

For this demonstration you will needs:

salt	water
ice cubes	drinking glass
foil pan	test tube or
candle	tea kettle

Mix salt in water, tasting the solution to be sure it is easily identifiable as salt water. Pour the solution into the test tube or a tea kettle and boil. Observe the water vapor rising from the top.

Place an ice cube in a foil pan and hold it in the path of the vapor. Notice how the vapor changes back to water, i.e. condenses. Taste the condensation on the bottom of the pan; it is not salty. Notice the crystals collecting in the test tube or kettle. Taste them when they are cool and you will find they are salt crystals. The process you have just completed is called distillation, and desalinization by this method is much too costly given current technology and the enormous scale of our water needs. If an economical process of desalinization were found, what impact would it have on various countries and on the ocean?

Soapmaking can be done in your own classroom. If you want to try it, the Lightship has one set of instructions you might want to look at.

Planning and predicting are other classroom activities. If you were building a world for a snail or fish or plant, what would you put in it? If you were rebuilding your own world or city, what would you want to include in it?

Using home-made or bought weather instruments, begin recording weather data daily, and try your hand at predicting weather. See the articles and hints on weather predicting from Mother Earth News and Weather-casting. We are grateful for permission to reprint these.

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TABLE FOR ESTIMATING RELATIVE HUMIDITY

WHEN USING WET AND DRY BULB THERMOMETERS

Air Temp. °F (Dry Bulb)	1	2	3	4	6	8	10	12	14	16	18	20	25	30
0	67	33												
5	73	46	20											
10	78	56	34	13										
15	82	64	46	29										
20	85	70	55	40	12									
25	87	74	62	49	25	1								
30	89	78	67	56	36	16								
35	91	81	72	63	45	27	10							
40	92	83	75	68	52	37	22	7						
45	93	86	78	71	57	44	31	18	6					
85	96	92	88	84	76	70	62	56	50	44	38	32	20	8
90	96	92	89	85	78	71	65	58	52	47	41	36	24	13
95	96	93	89	86	79	72	66	60	54	50	44	38	28	17
100	96	93	89	86	80	73	68	62	56	51	46	41	30	21

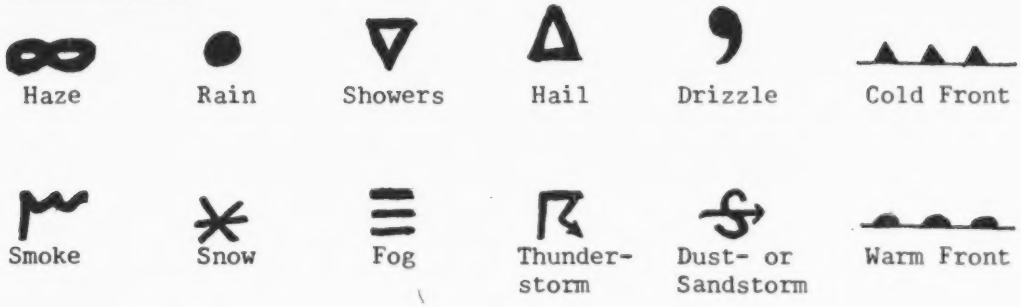
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
50	93	87	81	74	68	62	56	50	44	39	33	28	22	17	12
52	94	88	81	75	69	63	58	52	46	41	36	29	25	20	15
54	94	88	82	76	70	65	59	54	48	43	38	33	28	23	18
56	94	88	82	77	71	66	61	55	50	45	40	35	31	26	21
58	94	89	82	77	72	67	62	57	52	47	42	38	33	28	24
60	94	89	83	78	73	68	63	58	53	49	44	40	35	31	24
62	94	89	84	79	74	69	64	60	55	50	46	41	37	33	29
64	95	90	85	79	75	70	66	61	56	52	48	43	39	35	31
66	95	90	85	80	76	71	66	62	58	53	49	45	41	37	33
68	95	90	85	81	76	72	67	63	59	55	51	47	43	39	35
70	95	90	86	81	77	72	68	64	60	56	52	48	44	40	37
72	95	91	86	82	78	73	69	65	61	57	53	49	46	42	39
74	95	91	86	82	78	74	70	66	62	58	54	51	47	44	40
76	96	91	87	83	78	74	70	67	63	59	55	52	48	45	42
78	96	91	87	83	79	75	71	67	64	60	57	53	50	46	43
80	96	91	87	83	79	76	72	68	64	61	57	54	51	47	44

The upper table is for a temperature range of 0 to 100 degrees F. (Weathercasting, p. 27)

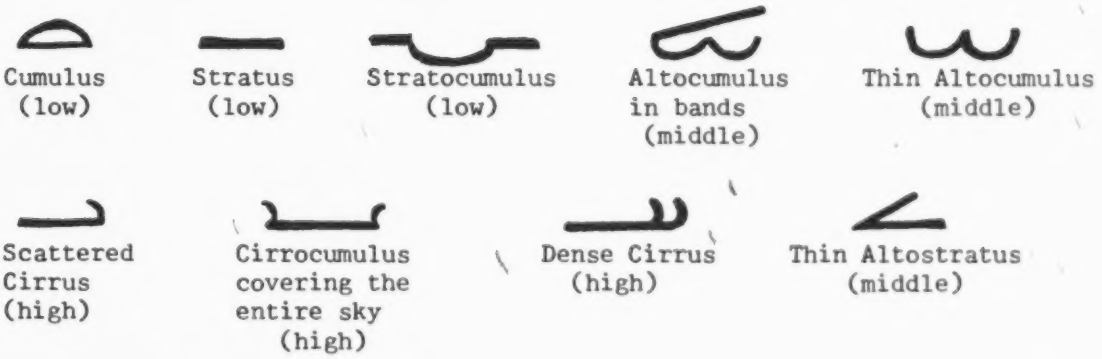
The lower table gives greater detail for temperatures of 50 to 80 degrees F., and may be more useful in the spring or fall (Our Environment: How We Use and Control It, p. 483)

WEATHER MAP SYMBOLS *

Weather Symbols



Cloud Symbols



Air Pressure Symbols